REMARKS

The above listed claim amendments and the following remarks are believe fully responsive to the Office Action. By this Response claims 4, 6, 9, 10-15, 19, 20-22, 24, 26, 27, and 31 are amended and claim 5 cancelled, where claims 17, 23, and 34 were previously cancelled, such that claims 1-4, 6-16, 18-22, 24-33, and 35 are pending in the application.

Phone Interview

The undersigned thanks the Examiner for the phone interview of February 14, 2008. The independent claims and the Cleer reference were discussed, although no substantive agreement as to the allowance of the claims was reached during the interview.

Support for Claim Amendments

Support for the amendments to the claims can be found throughout the application, for example at paragraphs 10 (e.g., describing absorbing generated heat into a system panel and transferring the absorbed heat into liquid in a conduit), 24 (e.g., describing heat transfer), 34 (e.g., describing absorbing heat from combustion chamber), and 42 (e.g., describing insulating properties) of the application publication.

Rejections under 35 U.S.C. §§ 102, 103

Claims 1-16, 18, 19, 21, 22 and 24-35 stand rejected under 35 U.S.C. 103(a) as unpatentable over U.S. Patent 4,025,043 ("Cleer") in view of U.S. Patent 5,941,237 ("Shimek"). Claim 20 stands rejected under 35 U.S.C. 103(a) as unpatentable over Cleer in view of Susany (5,915,374). The pending claims are patentable for at least the following reasons.

Claim 1 as amended relates, in part, to a hydronic heating system including a combustion chamber enclosure having a plurality of panels. A conduit is substantially embedded in at least one of the plurality of panels, the conduit being configured to carry a heat conductive liquid. The at least one panel has insulating properties such that the panel is

configured to absorb heat from a heat source and transfer the absorbed heat to the liquid in the conduit while resisting formation of condensation on the panel. For at least the following reasons, claim 1 is patentable over the cited references.

Cleer does not provide for, and actually teaches away from, a combustion chamber enclosure having a plurality of panels with a conduit substantially embedded in at least one of the plurality of panels, the conduit being configured to carry a heat conductive liquid and the panel having insulating properties such that the panel is configured to absorb heat from a heat source and transfer the absorbed heat to the liquid in the conduit while resisting formation of condensation on the panel. It is believed that none of the cited references overcome this teaching away. Furthermore, a declaration under 37 CFR 1.132 from David C. Lyons ("the Lyons Declaration") is provided herewith as further evidence that the state of the art at the time of invention teaches away from the features of claim 1 and the modification of Cleer forwarded in the Office Action.

Cleer repeatedly refers to water jacket 10 as being formed of metal. *E.g.*, Cleer at col. 2, ll. 6-11 ("the metal water jacket"); col. 3, ll. 3-5 ("spaced metal wall members"); col. 6, ll. 31-34 ("the welded-steel jacket 10 of the present invention"). Cleer also specifically states that "any suitable <u>heat-conducting material</u> is suitable for forming the structural components of the jacket 10" although "preferably all the walls of all the chambers will be formed of <u>plate steel</u>, the individual wall portions being <u>welded together</u> at the interfaces thereof." *Id.* at col. 3, ll. 42-48 (emphasis added).

In view of Cleer's description, one of ordinary skill would appropriately read Cleer as forwarding the use of metal materials having higher thermal conductivities ("suitable heat-conducting material"), i.e., materials similar to plate steel. This teaches away from a panel having insulating properties according to the features of claim 1. The Office Action forwards modification of Cleer using materials described in Shimek. However, Shimek does not provide any guidance for hydronic heating applications. As such, one of ordinary skill in the art seeking to have a reasonable expectation of success addressing issues associated with hydronic heating would look to metal materials, or at the very least more heat conductive materials, as forwarded in Cleer. Similarly, Susany fails to address the particular challenges

associated with hydronic heating applications and as such, fails to provide sufficient guidance to overcome the teaching away of Cleer and a reasonable expectation of success.

The Lyons Declaration and the evidence provided therewith also supports the Applicants' position that the cited references fail to provide the features of claim 1 and would not be modified as suggested in the Office Action to provide such features. In particular, the Lyons Declaration shows that the thinking by those of ordinary skill in the art at the time of invention was to employ metals and materials having higher thermal conductivities and <u>not</u> materials having insulative properties to transfer heat to liquids in hydronic heating applications. No evidence to the contrary has been cited in the Office Action. For at least such reasons, withdrawal of the rejection, allowance of the claim, and notice to that effect are respectfully requested.

Independent claims 14, 19, and 27 are similarly distinguishable from the cited references.

Claim 14 relates, in part, to a conduit adapted to carry a liquid and a combustion chamber enclosure having a plurality of panels defining a combustion chamber for the combustion of fuel to generate heat, the panels having insulative properties and the conduit being substantially embedded within at least one of the panels.

Claim 19 as amended relates, in part to forming a panel from a moldable material having insulative properties and including a ceramic fiber and a binder, the panel being adapted to resist formation of condensation on an outer surface of the panel and encapsulating a conduit in the panel such that the panel is adapted to absorb and conductively transfer heat to a liquid in the conduit.

Claim 27 relates, in part, to a heat exchanger including a molded panel of insulative material including a ceramic fiber and a binder and a liquid-filled conduit embedded within the molded panel where the molded panel is coupled to a combustion chamber enclosure.

The remaining claims depend, in some form, from one of independent claims 1, 14, 19, or 27. Although grounds for further distinguishing the dependent claims should be recognized, they are allowable for at least the reasons previously-described in association with the claims from which they depend.

In sum, withdrawal of the rejections, allowance of the pending claims and notice to that effect are respectfully requested. The Examiner is invited to contact the undersigned at the number below to facilitate prosecution of this matter.

Respectfully Submitted,

By: /Victor P. Jonas, Reg. No. 58,590/
Victor P. Jonas, Reg. No. 58,590
612-766-7835
Customer No.: 58506

Dated: April 21, 2008

fb.us.2720275.01

APPENDIX

- Declaration of David C. Lyons (executed April 17, 2008)
- U.S. Patent No. 6,029,648 (issued February 29, 2000)
- U.S. Patent No. 5,329,920 (issued July 19, 1994)
- U.S. Patent No. 4,025,043 (issued May 24, 1977
- "Stainless Steel Comparison," Central Boiler – Outdoor Wood Furnaces Website www.centralboiler.com/stainless.html (last visited on March 17, 2008)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Gary Lee Butler et al.	**Examiner:**	BOLES, Derek S.
Appln. No.:	10/800,142	**Group Art Unit:**	3749
Filing Date:	March 12, 2004	**Confirmation No.:**	6797
Title:	FIREPLACE HYDRONIC HEATING	**Customer No.:**	58506
		Docket No.:	77012 - 325648

Mail Stop RCE
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

I CERTIFY THAT ON APRIL 21, 2008, THIS PAPER IS BEING TRANSMITTED ELECTRONICALLY TO THE U.S. PATENT AND TRADEMARK OFFICE.

Lisa Johnson

DECLARATION OF DAVID C. LYONS IN SUPPORT OF PATENTABILITY UNDER 37 C.F.R. § 1.132

Dear Sir:

I, David C. Lyons, hereby declare that:

1. I currently reside at 3365 Wild Turkey Lane, Red Wing, Minnesota 55066.

2. I received a Bachelor of Science degree in Manufacturing Engineering from the University of Wisconsin – Stout in 1987.

3. I have over 20 years of experience in manufacturing and research and development engineering. I have been employed in the heating appliance industry for the past fourteen years. Currently, I am Vice President of Research and Development at Hearth & Home Technologies, Inc. a subsidiary of HNI Technologies, Inc., where I oversee product development of hearth systems.

4. I have been involved in fireplace and heating appliance technology development and am named as an inventor on over twenty patent applications in the field. Additionally, I have personally field-installed over 100 fireplaces, been on numerous service calls to consumers' homes for fireplace and heating appliance issues, and closely followed technological developments in the industry throughout my career.

5. I have reviewed and am familiar with the subject matter set forth and claimed in the above-referenced application, Application No. 10/800,142 ("the Application), including the claim amendments presented with the Amendment accompanying this affidavit.

6. My knowledge of the industry provides me with an understanding of what those of ordinary skill in the art around the time of invention of the claimed subject matter of the Application would have considered the proper material to use in a hydronic heating applications associated with fireplaces and heating appliances.

7. I believe that around the time of invention of the claimed subject matter those of ordinary skill in the art believed that materials having high thermal conductivity, and in particular metals, were the proper materials to through which to conduct heat from a heat source to liquid conveyed through conduits in panels. I also believe that those of ordinary skill in the art would not have predicted that more insulative materials, such as those claimed in the Application, would be desirable to use for paneling material that transfers heat from a heat source to liquid contained in conduits in the paneling material.

8. Portions of the Application address panels having a relatively high thermal lag. Materials with relatively high thermal mass (as determined by material heat capacity and thermal conductivity) have high thermal lags. Materials with high thermal lags have a slower response time, and are less susceptible to abrupt temperature variations. For example, when a relatively cooler liquid enters conduits

embedded in a panel formed of a material having insulating properties, the panel is not cooled as quickly, and condensation does not form on the panel. This is to be directly contrasted to the more conductive, metal materials employed by those of ordinary skill in the art around the time of the claimed invention.

9. The references discussed in the following paragraphs support my understanding that the state of the prior art would have led the ordinary artisan away from the claimed invention around the time of invention thereof.

10. I have reviewed and I am familiar with attached U.S. Patent 6,029,648 ("the '648 Patent"). The '648 Patent relates to outside, natural draft combustion, wood-burning furnaces and provides for a furnace including a water box assembly, a fire box assembly, copper tubing in the water box, and various plumbing connections for water flow into the water box assembly. Optional copper tubing is used to circulate water through the furnace for heat transfer from the water in the water box to water in the copper tubing, where the copper tubing is connected to tubing, pipes, or the like for heated water flow to a domestic water heater. The '648 Patent supports my understanding that, at or before the time of invention, the common thinking in the heating appliance industry was that more thermally conductive materials, such as metals, and not materials having insulative properties, should be used for water box and tubing construction where heat transfer from a fire box to the liquids contained in one or both of the water box and tubing was desired. For example, at column 4, lines 8-46 and column 5, lines 3-32 the '648 Patent specifically describes that the water box and firebox are preferably made of sheet steel, that tubing used to transfer heat to water contained therein is made from copper. The cited portion mentions insulation, but that insulation is used outside of the water box (between the skin of the furnace and the outside of the water box) and is not used to transfer heat to liquid in the water box.

11. I have reviewed and I am familiar with attached U.S. Patent No. 5,329,920 ("the '920 Patent"). The '920 Patent relates to outdoor, self-contained

wood fueled furnaces and provides for a stove constructed in a double walled configuration with a water-tight, external housing ("water box") surrounding an internal water-tight firebox ("firebox"). The cavity between the water box and the firebox contains a water based liquid heat transfer medium which is piped through a structure (e.g., a house) to be heated. The '920 Patent also supports my understanding that around the time of invention, the ordinary artisan would have viewed more thermally conductive materials, and in particular metals such as steel, as the proper materials through which to conduct heat from the firebox into the liquid. For example, at column 4, lines 36-49 the '920 Patent specifically describes that the walls of both the external water box and the internal firebox should be constructed of seven gauge steel sheet stock. Furthermore, as described at column 4, lines 37-43, the '920 Patent indicates that an insulating material (a firebrick liner) would only be positioned inside of the firebox at the bottom of the firebox if the water box (referred to as the "heat exchanger housing 22") does not extend about the bottom of the firebox (i.e., to avoid having the insulating material interfere with heat transfer into the liquid in the water box).

12. I have reviewed and I am familiar with attached U.S. Patent No. 4,025,043 ("the '043 Patent"). The '043 Patent relates to a heating system for heating a confined area with an open-hearth wood-burning fireplace and provides for a fireplace including a water jacket which comprises a multi-chambered double-walled arrangement or a grate member. Log supporting portions of the water jacket slant upward slightly in order to prevent a pinging sound by creating convectional force when water is circulating therethrough. The '043 Patent supports my understanding that, at or before the time of invention, the common thinking was that more thermally conductive materials, and in particular metals, were the proper materials through which to conduct heat from the firebox into the liquid. For example, at column 2, line 6, the '043 Patent specifically refers to the water jacket as the "metal water jacket" and at column 3, lines 42-48 the '043 Patent specifically describes that the water jacket and all of the chambers are preferably made of plate steel. The '043 Patent

also indicates that "any suitable heat-conducting material" can be used for the water jacket. As supported by the surrounding portions of the '043 Patent and the evidence presented herewith, "any suitable heat-conducting material" would be commonly understood to require a more thermally conductive material, and likely a metal material.

13. I have reviewed and I am familiar with the attached article, "Stainless Steel Comparison," taken from the Central Boiler – Outdoor Wood Furnaces Website located at www.centralboiler.com ("the Central Boiler Article") (as last visited on March 17, 2008). Although I cannot determine when the Central Boiler Article was authored or when it would have been available, the portion of the article entitled "Thermal Conductivity," which describes the relation of thermal conductivity to furnace design, is generally consonant with the common understanding of hydronic heating application materials around the time of invention. In particular, that portion of the article buttresses the conclusion that it would have been understood necessary to use highly thermally conductive materials, not insulative one, as "a firebox material with higher thermal conductivity will boost the efficiency of your outdoor wood furnace by transferring more btu's into the water jacket, instead of out your chimney."

14. The foregoing evidence supports my understanding that in heating appliance construction for hydronic heating applications, those of ordinary skill in the art would have been led away from use of materials having insulating properties, ceramic moldable materials, ceramic fiber and binder materials, and the materials having insulating properties described in the Application.

15. I declare that all statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true and, further, that these statements are made with the knowledge that willful, false statements and the like so made are punishable by fine of imprisonment, or both, under § 1001 of Title 18 of the United State Code, and that such willful, false

statements may jeopardize the validity of the Application or any patent issuing thereon.

Respectfully submitted,

Dated: April 17, 2008

David C. Lyons

fb.us.2712242.03

US006029648A

United States Patent [19]
Willis

[11] **Patent Number: 6,029,648**

[45] **Date of Patent: Feb. 29, 2000**

[54] **OUTSIDE WOOD-BURNING FURNACE**

[76] Inventor: **W. Coy Willis**, Apollo Engineering, 22161 Stipps Hill Rd., Laurel, Ind. 47024

[21] Appl. No.: **08/995,143**

[22] Filed: **Dec. 29, 1997**

[51] **Int. Cl.**^{7} **F24D 9/00**; F23M 7/00; F23M 7/04; G05D 23/12

[52] **U.S. Cl.** .... **126/101**; 126/197; 126/285 R; 110/173 R; 110/175 R; 122/498; 236/99 R

[58] **Field of Search** .... 126/101, 293, 126/197, 285 R, 190; 122/15, 498; 110/173 R, 174, 176, 178, 175 R; 236/99 R, 99 F, 99 H

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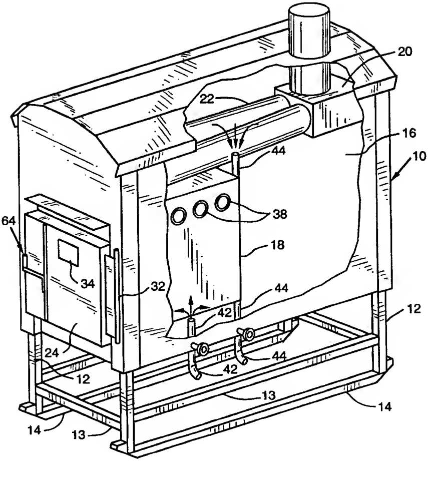
Primary Examiner—Ira S. Lazarus
Assistant Examiner—David Lee
Attorney, Agent, or Firm—David W. Brownlee; Eckert Seamans Cherin & Mellott, LLC

[57] **ABSTRACT**

A natural draft furnace has a firebox inside a water box with fire tubes containing water running through the firebox, flues from the firebox running through the water box, a front/fire door of double wall construction to preheat entering air, a damper in the fire door and a toggle-lock latching system on the fire door that provides uniform sealing pressure around the door.

19 Claims, 11 Drawing Sheets



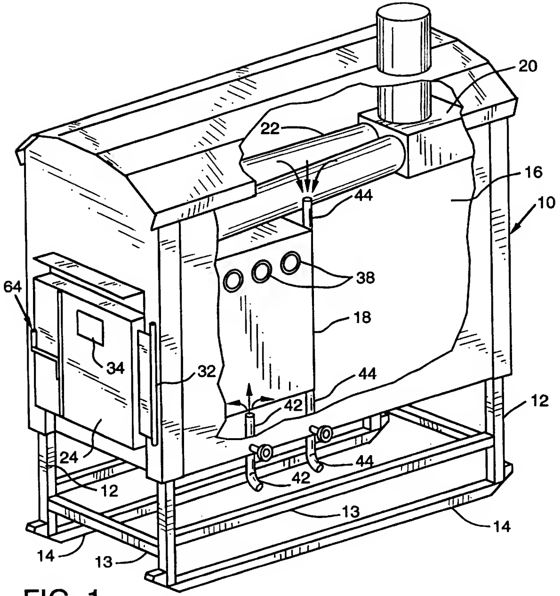


FIG. 1

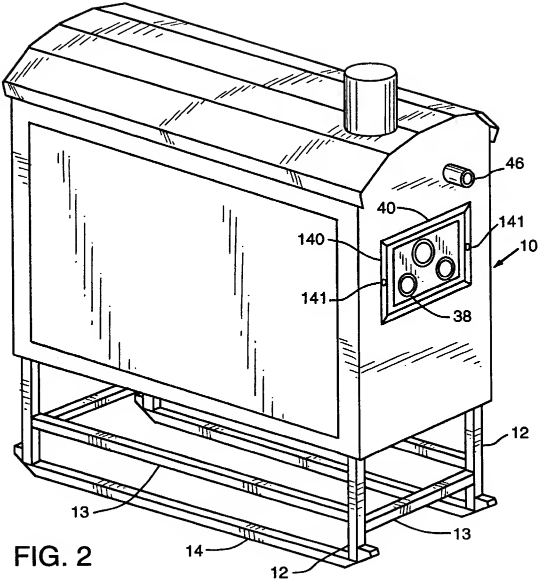


FIG. 2

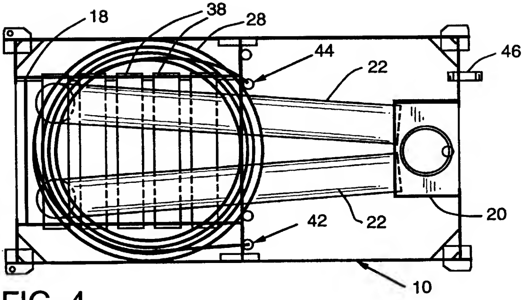


FIG. 4

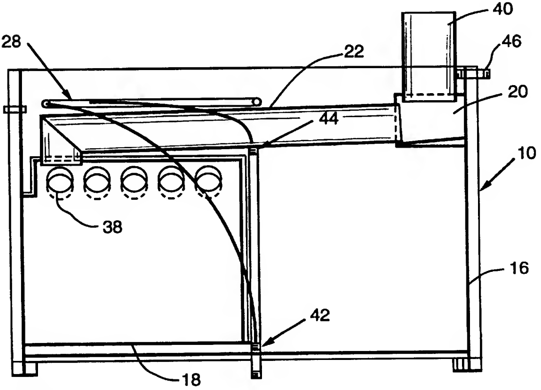


FIG. 3

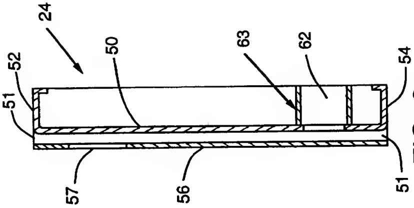


FIG. 6

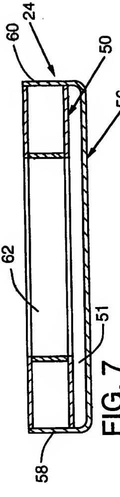


FIG. 7

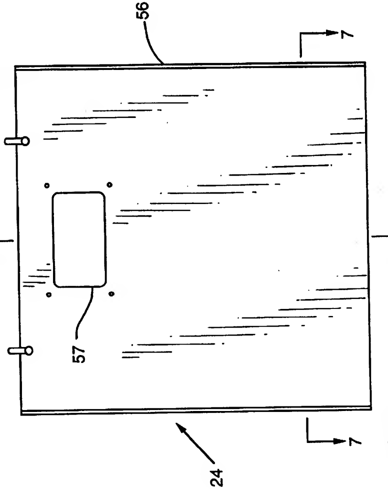


FIG. 5

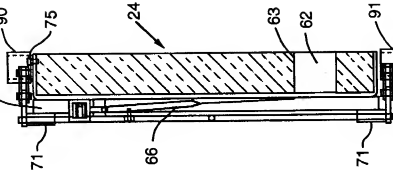


FIG. 9

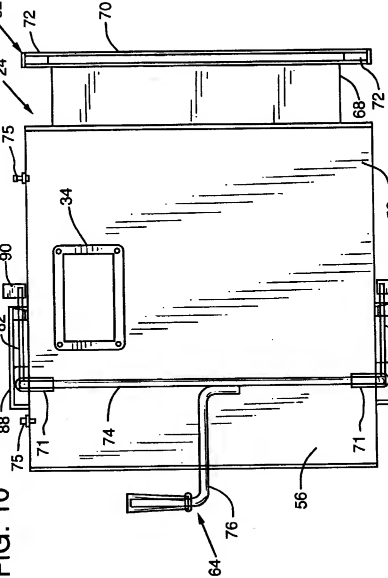


FIG. 8

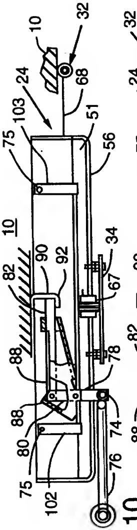


FIG. 10

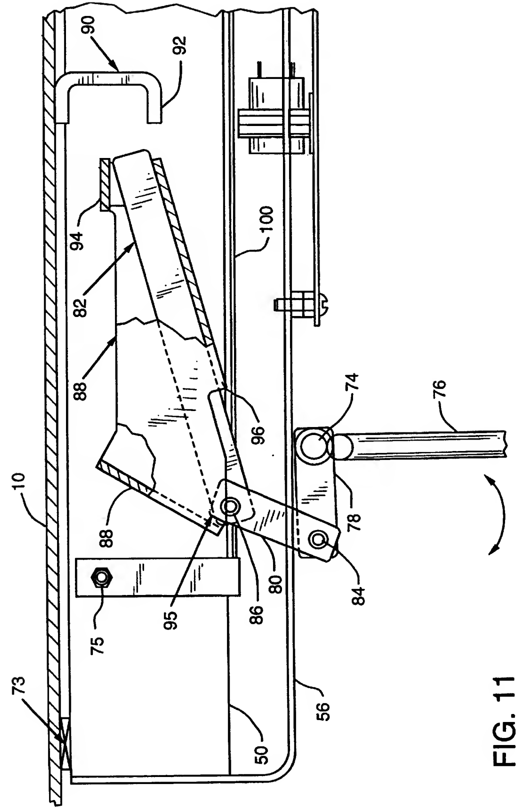


FIG. 11

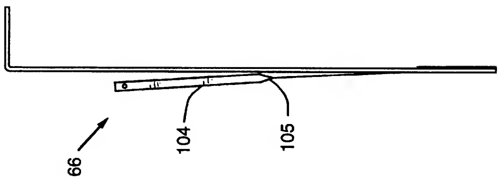


FIG. 13

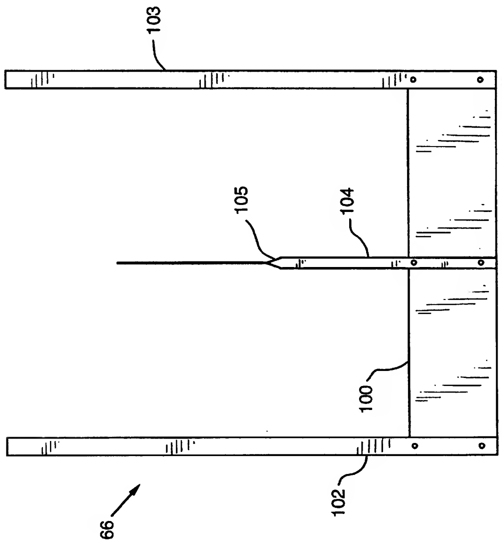


FIG. 12

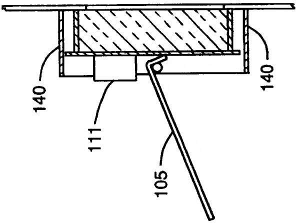


FIG. 17

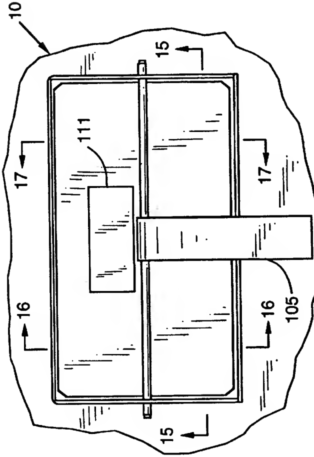


FIG. 14

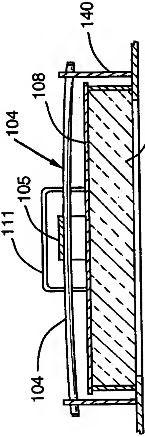


FIG. 15

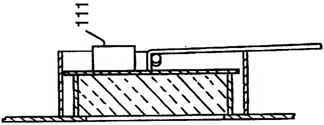


FIG. 16

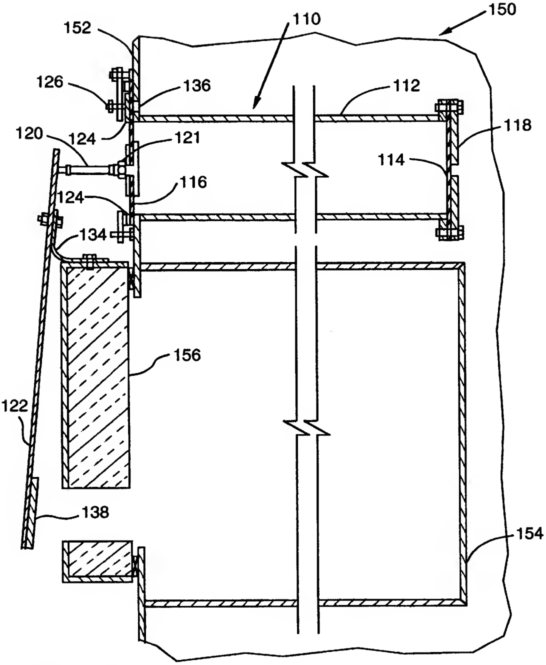

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FIG. 18

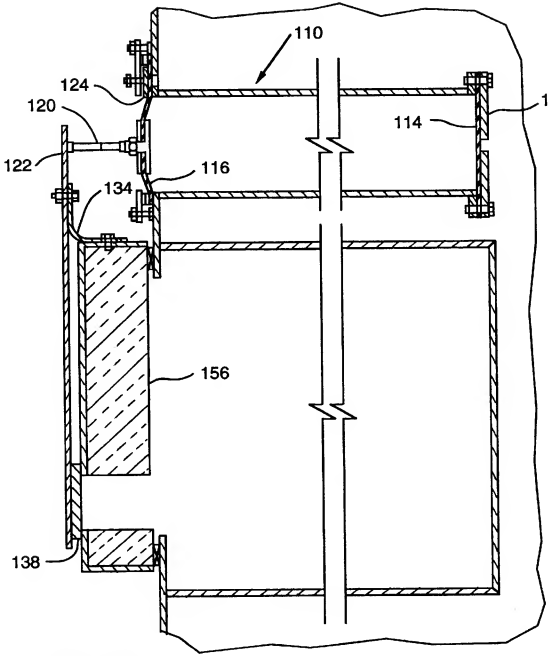

FIG. 21

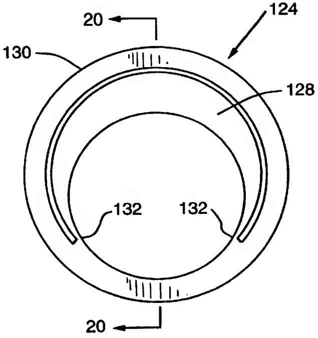

FIG. 19

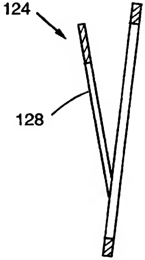

FIG. 20

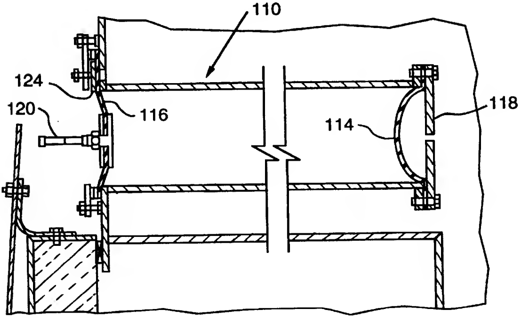

FIG. 22

OUTSIDE WOOD-BURNING FURNACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to furnaces for heating homes, garages, shops, grain dryers and the like and particularly to a type of furnace generally referred to as "outside wood-burning furnaces". Although called outside wood-burning furnaces, they are sometimes placed inside buildings and many also burn fuels other than wood. The furnace of this invention is best suited for using water as a heating and heat storage medium. Hot water is circulated from the furnace to remote areas where heat is extracted by some form of heat exchanger.

2. Description of the Prior Art

Outside wood-burning furnaces are commonly used throughout the United States, Canada and other countries in rural areas where there is an abundant supply of wood. The furnaces are used to heat homes, shops, barns, garages, swimming pools, hot tubs, clothes dryers, hot water heaters, grain dryers and other buildings and devices. Since the furnaces are typically located outside the home, they avoid the need to carry firewood into the home or remove ashes from the home. They also avoid the sooty messes in the home that sometimes occur with wood burning furnaces, avoid obnoxious smells and possibly dangerous gases that occasionally come from wood-burning furnaces, and avoid annoying insects that may be brought into the home with firewood. They also avoid the possibility of damaging fires to homes.

Outside wood-burning furnaces are sometimes housed in small utility buildings or can include shielding to protect the furnaces from the elements. They may also be located inside other buildings such as barns or garages.

Although outside wood-burning furnaces have been in use for many years, the furnaces leave much to be desired in the terms of performance, convenience, appearance and cost. There is a need for an improved outside wood-burning furnace having improved performance and reliability and which can be manufactured by modern manufacturing methods. An outside wood-burning furnace is needed which is safe and convenient to operate and which strikes a good balance between cost, efficiency, and cleaning convenience. Such a furnace also needs to be attractive from all points of view.

SUMMARY OF THE INVENTION

This invention provides an outside, natural draft combustion, wood-burning furnace that satisfies the need for improved performance, convenience and appearance at a reasonable cost. The furnace is well suited to be manufactured in volume using modern manufacturing methods. Given sufficient quantities of production runs, the furnace can be manufactured at low cost and high quality. The furnace is also safe and convenient to operate and can be operated with or without electrical power. The furnace is attractive from all points of view and the design permits the customer to select different color schemes. The furnace is designed with the consumer in mind.

The furnace of the invention has a greatly improved fire door which applies uniform sealing pressure of the sealing gasket against the fire box around the complete perimeter of the door and includes a toggle-lock latching system. The door is connected to the furnace through a hinge pin which is spaced from one lateral edge of the door, and the locking latch system uses a flexible outer wall of the double wall door and flexible hinge construction to act as a spring to hold the door against the fire box. The locking pressure is applied in the center of the door rather than at one side.

The double wall fire door of the invention also includes a self-cooling, energy saving, air preheating, vertical draft chamber between the hot inner side of the door and cooler outside surface of the door. A preferred embodiment further includes an automatic fail-safe damper that shuts off the air in the event of a power failure to prevent overheating and boiling the water from the furnace. The damper can be manually operated if necessary.

A furnace of this invention includes cross-fire tubes that are suspended inside the fire box above the fire where the flames and flue gases must filter past the tubes on their way out of the fire box. This direct contact of hot gases with fire tubes transfer the heat energy from the hot gases directly into the water in the water box of the furnace.

A furnace of this invention further preferably includes two horizontal flue pipes that are surrounded by water in the water box to extract additional heat from the flue gases before the gases are exhausted from the furnace. These pipes extend almost the entire length of the furnace and provide considerable surface area for heating the water in the water box.

Another preferred feature of this invention is a rear service door to provide access to all internal flue systems for inspection, cleaning and servicing.

To ensure that heat stays where it should, the entire furnace is surrounded by heat-saver insulation blankets to minimize heat loss. The furnace is preferably wrapped in about two inches of closed cell foam having a high R-value. Both doors are filled with light-weight insulating refractory cement. Precoated sheet metal roof, side walls, front wall and rear wall are positioned over the foam insulation for protection from the elements and to provide a pleasing appearance for the furnace. The laminated side panels are easily removable to permit convenient choice of colors during or after manufacture of a furnace.

A furnace of this invention can include dampers which are operated either electrically, manually or hydrostatically. One embodiment includes a hydrostatic thermostat which is operated by changes in the volume of water in a water filled conduit or tube that is located in the furnace. This embodiment is particularly well suited for furnaces used in remote locations where electrical power is not readily available and also for use by religious sects that do not use electricity.

It is therefore seen that a furnace of this invention offers many improvements and advantages for the user.

Accordingly, an object of this invention is to provide an outside woodburning furnace which has improved performance, convenience, safety, and appearance at reasonable cost.

The above and other objects and advantages of this invention will be more fully understood and appreciated with reference to the attached drawings and the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a furnace of this invention in partial fragmentary to show a portion of the inside of the furnace.

FIG. 2 is a perspective view of the rear and one side of the furnace of FIG. 1.

FIG. 3 is a vertical cross-section through the furnace of FIG. 1, taken along the centerline of the furnace front to rear.

FIG. 4 is a top plan view of the furnace of FIGS. 1 and 2 with the roof and top panel of the furnace removed to show the inside of the furnace.

FIG. 5 is a front elevation of the fire door for the furnace of FIGS. 1–3 before the damper, solenoid, name plate and latch locking mechanism have been mounted to the door.

FIG. 6 is a cross-sectional view of the fire door of FIG. 5 taken on line 6—6 in FIG. 5.

FIG. 7 is a cross-sectional view of the fire door of FIGS. 5 and 6 taken along line 7—7 in FIG. 5.

FIGS. 8 and 9 are similar to FIGS. 5 and 6 and further showing a preferred toggle-latch locking mechanism, damper, solenoid and name plate mounted on the door.

FIG. 10 is a top view of the door assembly of FIGS. 8 and 9.

FIG. 11 is an enlarged top plan similar to FIG. 7 and showing the door latch in unlocked position.

FIG. 12 is a plan view of the damper in the door of FIGS. 8–10.

FIG. 13 is a side elevation of the damper of FIG. 12.

FIG. 14 is a vertical plan view of a rear door on the furnace of this invention.

FIG. 15 is a cross-section through the door of FIG. 14 taken on line 15—15 with the door locked on the furnace.

FIG. 16 is a cross-section of the door of FIGS. 14 and 15 taken along line 16—16.

FIG. 17 is a cross-section of the door of FIGS. 14–16 taken along line 17—17 and showing the door unlocked on the furnace.

FIG. 18 is a vertical cross-section through an alternative thermostat for a furnace of this invention.

FIG. 19 is a plan view of a burp valve plate used in the thermostat of FIG. 18.

FIG. 20 is a cross-section through the burp valve plate of FIG. 19 taken along line 20—20.

FIG. 21 is a vertical cross-section similar to FIG. 18 and showing the thermostat in the hot mode with the damper on the furnace in the closed position.

FIG. 22 is a vertical cross-section similar to FIGS. 18 and 21 and showing the thermostat in the cold mode with the damper in the open position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings show an outside wood-burning stove which is made mostly of sheet metal such as sheet steel that is assembled primarily by welding. The steel sheet material may be 10, 12, 14 gauge for different parts depending on the size and strength requirements for the part. Other parts may be made of stainless steel or aluminum. Various other materials and methods of interconnection will be described where appropriate.

The term outside wood-burning furnace is used in the broad sense to describe the type of furnace and not to limit it to outside locations nor to the use of wood as fuel. The furnace may be located inside a building and can burn other fuels such as coal, gas or fuel oil.

Referring first to FIGS. 1–4, a preferred embodiment of a furnace **10** of this invention is shown as mounted on a main body assembly having a frame of legs **12**, braces **13** and skids or support rails **14** made of rectangular steel tubing on which the furnace is supported. The furnace is adapted to be slid or dragged from place to place on the support rails **14**. The furnace includes insulated sheet metal side walls, a front outside wall and rear outside wall and roof which are preferably made of colored plastic sheet material with approximately 2 inches of urethane foam insulation laminated to the interior faces of the plastic sheet material. The walls are designed to be easily removed for interchangeability of colors on the furnace.

The furnace **10** includes a water box assembly **16**, a fire box assembly **18**, a smoke or flue box assembly **20**, a pair of substantially horizontal flues **22** connecting the fire box to the flue box, a front door assembly **24**, a rear door assembly **26** (FIGS. 14–17), optional copper tubing **28** in the water box, and various plumbing connections for water flow into the water box assembly and for water flow through the copper tubing. The front door assembly **24** in the preferred embodiment includes a toggle locking mechanism **64**, a damper assembly **66** (FIGS. 12 and 13), a name plate **34** and a solenoid mechanism **67** (FIG. 10) for operating the damper as will be described. The front door assembly **24** has a special double wall design with a vertical air passage between the two walls for natural draft, fresh air to flow through and into the fire box **18** to support combustion.

The water box assembly **16** is preferably made of sheet steel welded together with a heavy weld, water tight, at all seams from the inside of the tank. As the name implies, the water box **16** is designed to be substantially filled with water which is heated by combustion in the fire box **18** assembly which is located centrally in one end of the water box. The fire box assembly **18** is also made of sheet steel which is heavy welded, water-tight at the seams and welded into a rectangular opening at one end of the water box. The fire box **18** is supported in the water box **16** by a support strap, not shown, so the fire box is surrounded by water in the water box except at the fire door **24**.

The fire box assembly **18** has a plurality of fire tubes **38** extending horizontally through it adjacent the top of the fire box. The fire tubes **38** are preferably open on both ends for water from the water box **16** to flow through the fire tubes. The fire tubes **38** are welded, water-tight, into both side walls of the fire box **20** and are preferably sloped slightly (about 5°) to horizontal to create a thermal gradient of water in the tubes and cause a natural flow of water therethrough as a result of such thermal gradient. The fire box **18** has an open end where the fire box is welded to the water box **16** and where the front (fire) door **24** is located.

The two flues **22** are welded at one end of each of the top of the fire box **18** which has openings in it corresponding to the open ends of the flues **22**. The flues extend generally horizontally at an upward slope at about 1–5° from the fire box **18** to the flue box assembly **20** and are welded to an end wall of the flue box assembly at openings therein corresponding to the open ends of the flues. The slope of the flues **22** is desirable so any creosote or water that may collect in the flues or the flue box **20** will drain into the fire box **18**.

The flue/smoke box assembly **20** is welded to the rear wall of the water box assembly **16** at an opening in the water box corresponding in size to the flue box. The flue box **20** has a similar opening in its rear wall for access from the outside of the furnace into the flue box. A rear door assembly **26** (FIGS. 14–17) closes the opening into the flue box **20**.

The flue box **20** further has an opening in its top wall and has a flue pipe **40** inserted into the opening and welded to it around the full perimeter of the opening and the flue pipe. The flue pipe **40** extends upwardly through the roof of the furnace for exhaust of combustion gases to the outside. A flue pipe extension can be added on the top of the flue pipe

40 to increase the height of the exhaust and increase the draft through the furnace.

As best shown in FIGS. 3 and 4, the furnace 10 may optionally include soft copper tubing 28 for circulation of water through the furnace for heat transfer from the water in the water box 16 to water in the copper tubing. The tubing 28 may be connected to vertical inlet and outlet water pipes 42 and 44 adjacent the rear of the fire box 18. The pipes 42, 44 extend through the bottom wall of the water box 16 and have fitments on them for connection to tubing, pipes or the like for water flow to a domestic (home) water heater. The furnace 10 preferably has a second set of inlet and outlet pipes and connections, not shown, to the water box for water flow to and from heat transfer apparatus at a building or apparatus to be heated by the furnace. In the preferred embodiment both inlet pipes are relatively short and extend only a short distance above the bottom of the furnace and the outlet pipes are longer and extend to about the height of the fire box 16 or slightly above the top of the fire box so the hot water near the top of the water box 16 is delivered to the heat exchanger and the spent (cold) water is returned to the bottom of the water box in a manner similar to a domestic hot water heater.

The furnace 10 has a front outside wall, rear outside wall, side skins and roof made of pre-coated sheet metal or polymer plastic material which is corrosion resistant and protects the furnace from the elements. The furnace has insulation located between the water box and the skin of the furnace to minimize heat loss from the furnace. The insulation is preferably closed-cell urethane foam, about two inches thick having a high R-value. As stated above, the walls, side skins and roof of the furnace can be easily removed and replaced.

The water box 16 further has a fill/vent opening 46 in its rear wall and a suitable valve opening (not shown) for draining water from the box. As a safety measure, the opening 46 cannot be closed since the vent must remain open to avoid pressure build-up in the water box and avoid any risk of explosion of the furnace. Water circulates in the water box as a result of the natural convection as it is heated through the fire tubes 38 and flue pipes 22 and by the walls of the fire box 18. This natural convection enhances heat transfer from the fire box 18 to the water in the water box 16. Antifreeze and/or other additives can be put into the water in the water box 16 to prevent freezing of the water in the water box when the furnace is not in operation and prevent corrosion of the inside of the water box and outside surfaces of the fire box 18, flue box 20, and flues 22.

The rear opening into the flue box 20 in the furnace 10 is best seen in FIG. 2. This opening provides access to the inside of the flue box 20 for inspection, cleaning and servicing the flue box, the horizontal flues 22 and the flue pipe 40. The rear door assembly 26 (FIGS. 14–17) is preferably not hinged or otherwise connected to the furnace except with a removable latch that secures the door in place. The rear door is preferably made of stainless steel and is filled with insulating cement to minimize heat loss through the door.

It is a feature of this invention that the front door 24 to the fire box 18 in the furnace 10 is a double wall construction that forms a vertical air passage for fresh air to enter the fire box. It is a further feature that the door has a fail safe damper mounted in it that shuts off air flow in the event of a power failure. Still another important feature of the front door is a toggle-lock latching mechanism that applies substantially uniform sealing pressure of the door gasket around the complete periphery of the door. The toggle lock mechanism applies closing force near the vertical center of the door rather than a lateral edge of the door as with most furnaces.

The front door assembly 24 of this invention is best seen in FIGS. 5–7. The assembly is a double wall construction including a sheet metal door divider 50 having a top and bottom re-entry flanges 52, 54 as seen cross-section and a door shell 56 which have re-entry flanges 58,60 on opposite vertical edges. The vertical wall of divider 50 is spaced from the vertical wall of shell 56 to provide a vertical passageway 51 therebetween. The divider 50 has a center opening 62 toward the bottom of the divider and draft opening frame 63 welded to the inside of the divider to provide a draft opening when insulation is applied against the inside surface of the divider around the draft opening frame as is seen in FIG. 9. The space between the divider 50 and the shell 56 is closed on both lateral edges of the door by the flanges 58, 60 on the shell 56 but is open at both the top and bottom of the door for fresh air to flow into and through the space or passageway 51 and into the draft opening 62 in the door. The shell 56 has a rectangular opening 57 through it for mounting a solenoid and name plate on the door 24.

FIGS. 8, 9 and 10 are similar to FIGS. 5, 6 and 7 except FIGS. 8, 9 and 10 further show a hinge assembly 32, toggle latch locking mechanism 64 and damper assembly 66 and solenoid 67 on the door 24. The hinge assembly 32 includes a hinge web 68 welded to the flange 60 on the door shell 56 and projecting laterally from the door for attachment to the front wall of the furnace. The hinge assembly 32 further has a hinge pipe 70 for receiving a hinge pin 72 which is secured to the front wall of the furnace 10, by welding or otherwise securing it by hinge brackets 69 as is well known in the art. Its important that hinge pipe 70 is spaced from the lateral edge of the door by the hinge web 68 to provide a limited degree of flexibility to the hinge connection as will be explained.

The toggle-latch locking mechanism (latch assembly) includes a pivot rod 74, a door handle arm 76 welded to the pivot rod, top and bottom toggle arms 78, 79, upper and lower toggle straps 80, 81 and upper and lower locking arms 82, 83. The ends of the pivot rod 74 are pivotably disposed in pivot pipes 71 welded or otherwise fixedly secured to the outer surface of the shell 56 of the door so the pivot rod can turn or pivot in the pivot pipes on the door. The toggle arms 78,79, toggle straps 80,81, and locking arms 82,83 are pivotally connected through toggle pivot pins 84, 85, 86, 87 and the toggle arms 80, 82 are welded or otherwise fixedly connected to the ends of the pivot rod 74 to create the locking assembly. The door assembly 24 has upper and lower housings 88, 89 fixedly (preferably welded to on the top and bottom of the door to receive the locking arms 82, 83, and upper and lower latch U-hooks 90, 91 are secured (preferably welded) on the front of the furnace above and below the door to receiving one end of each of the locking arms 82, 83. The locking arms 82, 83 are confined within by the upper and lower housings 88, 89 by confinement points or interference points 94, 95, 96 as best seen in FIG. 11. The locking arms are limited to approximately 15° of rotation and sliding movement longitudinally within the housings 88, 89. The limited rotation of the locking arms stops the rotation of the handle 76 so the handle can be used to open and close the door. It would be difficult to control the door with the handle if rotation were not restricted.

FIGS. 8, 9 and 10 show the latch mechanism 64 in locked position and FIG. 11 shows it in unlocked position. As seen in FIG. 10, the upper locking arm 82 has one end thereof locked under hook or a flange 92 on latch U-hook 90 and the

other end confined inside of housing **88**. The door handle arm **76** is rotated toward the front face of the furnace and is disposed parallel to the front of the door. The pivot rod **74** and pivot pipes **71** pull outwardly on the front face of the outer shell **56** of the door by the clockwise rotation of locking arm **82** (compare with FIG. **11**) when the pivot rod **74** and toggle arm **78** are rotated clockwise by the door handle arm **76**. The outer shell **56** of the door is flexible sheet metal and acts as a spring, to accommodate manufacturing and gasket variability, by flexing outwardly (bowing) when the pivot rod **74** pulls against the shell. It is important that the toggle-latch mechanism **64** applies closing force against the door in a center portion (side-to-side) and along substantially the full height of the door to apply substantially uniform sealing pressure around the full perimeter of the door as permitted in part by the nature of the hinge connection as described above. Door gasket **73** provides a seal between the front door **24** and the end wall of the furnace **10** against air flow around the door and into the fire box **18**.

FIG. **11** shows the latch assembly **64** in unlocked position wherein the door handle toggle arm **78** and toggle strap **80** have been rotated counterclockwise. The locking arm **82** has also moved longitudinally within the housing **88** and retained in the housing by the confinement points **94, 95, 96**. The door can now be swung open because the inner end of locking arm **82** is not engaged under flange **92** on latch hook **90**. The latch assembly is held on the door by the confinement of the locking arm **82** within the housing **88** and it is not pinned, welded or otherwise connected to the door.

FIGS. **9, 12** and **13** show the damper assembly **66**, which is a special feature of this invention. The damper assembly includes generally flat damper **100** which is made of sheet metal, damper swing straps **102, 103** for mounting this damper **100** on the front door **24** and damper pull strap **101** for operating the damper. The damper pull strap **101** preferably comprises a strip of sheet metal having a half twist **105** in it between its ends to provide flexibility to the strap in all lateral directions. The bottom of the pull strap **101** is secured flush against the face of the damper **100**, and the top end is adapted to be attached to a solenoid **67** (FIG. **9**) that will move the strap vertically and cause the damper to move inwardly and outwardly as permitted by pivoting of the swing straps **102, 103** as permitted by loosely fitting screws **75** on the top of the door.

FIGS. **8, 9 10** and **11** show the damper assembly mounted on the front door **24**. The top ends of the swing straps are loosely secured to the top of the door with screws **75**, and the top end of the pull strap **101** is connected to a solenoid **67**. The damper **100** is positioned to open and close the inlet opening **62** through the door to regulate air flow therethrough. The damper plate **100** may optionally have one or more slots and bendable tabs along an edge thereof for admitting a limited (small) amount of air into the furnace even when the damper is closed so a fire in the fire box **18** will not be completely extinguished as long as fuel remains in the fire box.

The solenoid **67** can be an electrically operated in response to a signal from a conventional thermostat or an optional hydro-thermostat as described below. The solenoid **67** may be connected to a remotely located thermostat and operate with changes in temperature in the furnace or with changes in the temperature in the building or device which is heated by the furnace. With such changes in temperature, a thermostat at the remote location will send a signal to the solenoid **67** to either pull the pull strap **101** upwardly to open the damper or lower the strap to close the damper against the fresh air inlet in the door. The solenoid **67** shown in FIGS. **8, 9** and **10** is mounted on the inside of the name plate **34** on the door and is connected by means not shown to a temperature sensing thermostat on the furnace (preferably on the water box) and has an electrical connection, not shown, to power the solenoid. The name plate **34** acts as a heat radiator for the solenoid to keep it reasonably cool.

FIG. 2 shows the rear of a furnace **10** of this invention, and FIGS. **14–18** show a rear door assembly to close the rear access opening into the flue box **20**. As seen in FIG. **2**, the access into the flue box **20** provides access to the inside of the flue pipes **22** and the flue pipe **40**. The access opening preferably has a rectangular frame **140** around it in which the door assembly **26** is positioned and secured as described below. The rear door assembly **26** comprises a sheet metal shell **108** having cement insulation **109** in the shell and a handle assembly **107** which rotates around the outside face of the door as best seen in FIG. 17. The handle assembly **107** comprises a rod **104** and a handle **106** welded on the rod. To secure the door on the furnace, the ends of the rod **104** are inserted through holes **141** in opposite sides of the frame **140**, and the handle **106** is rotated downwardly as seen in FIG. 17. The inner end of the handle **106** presses against the outer face of shell **108** to press the door against the furnace so the door fits flush against the exterior face of the furnace end wall around the access opening. A sheet metal handle **111** may also be provided for convenience in gripping the door, and a gasket, not shown, may be provided to seal the door against the exterior surface of the furnace.

FIGS. **18–22** show an alternative thermostat **110** that can be used with a furnace of this invention. This thermostat **110** is a hydro- or water-operated thermostat which operates without electrical power. It is therefore suited for use in remote areas where electricity is not readily available or by certain religious sects that do not use electrical power.

Thermostat **110** is preferably positioned in the water box **152** of the furnace **150** adjacent to (preferably above) the fire box **154**, but may be at alternative locations in the furnace. The thermostat **110** comprises a cylindrical conduit or pipe **112** having a one-way diaphragm **114** on one end and a two-way diaphragm **116** on the other end. An end cap **118** is mounted on the end of the tube **112** over the one-way diaphragm **114**. The end cap **118** has a vent hole **119** in it for water in the water box to pass through and press against the diaphragm **114**. The diaphragms **114** and **116** are preferably made of neoprene or other elastomer material suitable for use in high temperature environments. The two-way diaphragm has a plunger **120** mounted centrally in it and projecting outwardly from the tube **112** to operate a damper strap **122** as will be described below. The plunger **120** preferably includes threaded means for adjusting its projection from the thermostat by screwing the plunger in and out of an adjusting stud **121**.

The thermostat **110** further has a burp valve plate **124** as shown in FIGS. **19** and **20** disposed on the end of the tube **112** and a burp screw **126** mounted on the furnace wall above the conduit and positioned against the outer face of the burp valve plate **124** over a burp hole through the wall of the water box **150**. As best seen in FIGS. **19** and **20**, the burp valve plate **124** is like a round leaf spring with an open center and a crescent-shaped spring member **128** connected to an annular ring portion **130** at hinge points **132**. FIG. **20** shows the plate **124** in a free state before assembly on the thermostat. The spring member **128** projects at an angle to the annular ring portion **130** when the plate is in the free state as seen in that Figure. The burp valve plate **124** is seen in cross section in FIGS. **18, 21** and **22** in the thermostat assembly.

The hydro thermostat **110** is adapted to be used with a modified damper assembly in which the pull strap **122** is mounted on the top of the front door **156** by a leaf spring **134** which holds the damper open as seen in FIG. **18**. As seen in that Figure, the thermostat plunger **120** is not fully extended. This shows the operating mode in which air is desired for maintaining combustion in the furnace and thereby maintaining heat output. As shown in FIG. **18**, the plunger rod **120** and damper have been adjusted as will be explained below. FIG. **21** shows the thermostat in the hot mode with the plunger **120** in contact with the pull strap **122** to close the damper **138** and stop, or substantially stop, the air flow into the furnace.

Adjustment of the hydro thermostat for operation will now be described. Upon installation of the thermostat, the water box **150** is filled with water to the proper height above the hydro thermostat **110**. The burp screw **126** is then backed off manually which allows the crescent-shaped leaf **128** of the plate **124** to follow the screw out. Water, as a result of gravity, flows through the burp hole **136** and fills the pipe **112**. Water is prevented from leaking to the outside as a result of the burp valve plate **124** forming a complete circular seal against the outer surface of the two-way diaphragm **116** around the hole in the furnace wall. After the pipe **112** is filled, a fire is started in the fire box **154** to raise the water to the desired temperature. When the water reaches the desired temperature, the burp hole **136** is sealed shut by manually tightening the burp screw **126**. The plunger **120** projection and the damper **138** are then set to their desired positions, and the system is set for operation, i.e., regulating the temperature through the expansion and contraction of the water inside the pipe **112**.

It can be seen that once the load from the leaf spring **134** and plunger arm **120** is brought to bear against the adjusting stud **121**, the pressure inside the pipe **112** will be raised slightly and will force the one-way diaphragm **114** back against the end cap **118**. As long as the pressure inside the pipe **112** is greater than the static pressure produced by the water head (height), the one-way diaphragm **114** will always rest against the end cap **118**.

It is desirable to control the temperature of water in a furnace to within plus or minus 5° of a desired operating temperature, such as 180° F., which is possible with the thermostat **110**. The amount of plunger **120** movement in the thermostat **110** responsive to changes in temperature of the water in the furnace is determined primarily by the inside diameter of the furnace wall/burp valve. This dimension can be established to provide the desired preciseness of temperature control.

It should be pointed out that the sensitivity of the temperature control mechanism, i.e., the movement of the plunger **120**, can be increased by decreasing the hole through the furnace wall and the corresponding hole through the burp valve, in conjunction with a smaller diameter on the plunger plates. With the one-way diaphragm **114** resting against the end cap **118** as described above and shown in FIG. **18**, it can be seen that by incorporating this feature, it is possible to control the temperature to a point approaching a steady state burn rate, which is a very desirable condition.

The importance of the one-way diaphragm **114** as opposed to a solid end cap is revealed when the water temperature falls below the set point. When the fire burns out, the water can cool down considerably below the set temperature. The reduction in temperature (sometimes as much as 80 to 100 degrees) will cause the water inside the unit to shrink considerably. FIG. **22** (cold mode) shows how the one-way diaphragm **114** accommodates most of the shrinkage of the water, thereby relieving the stress on the two-way diaphragm **116** or sucking in more water or air, both of which will upset the calibration of the unit.

Referring to FIG. **21**, it is noted that the thermostat **110** is designed to accommodate "temperature overshoot" by the plunger **120** outwardly beyond the closed position of the damper. This accommodation is possible due to the flexing of the leaf spring **134** and the damper strap **122** outwardly beyond that shown in FIG. **21** without in any way damaging the thermostat or damper. However, it should be noted that there should be little, if any, reason for such an overshoot to occur since one of the advantages of this system is the gradual or progressive opening and closing of the damper.

One of the disadvantages of most, if not all, prior art systems is that the damper in those systems is always either completely open or completely closed. They have no way to "gradually" open up the draft damper when the furnace needs heat or "gradually" shut down the draft when the furnace is approaching the desired temperature. This characteristics causes you to have a roaring fire up to a certain point and then it is completely shut down. This complete and sudden shutdown causes the system to smolder in an oxygen starved environment which results in excess creosote build up and an inefficient burning process.

In contrast with such complete shutdowns and openings, the "hydro thermostat" of this invention gradually opens up and closes to control the amount of fire needed to maintain the proper temperature. In other words, the hydro thermostat has the ability to keep the combustion running at a "steady state" condition. A steady state combustion process for a system like this is highly desirable from the standpoint of fuel efficiency and minimal creosote build-up.

It is therefore seen that this invention provides an improved outside wood-burning furnace that has superior performance, convenience, appearance and reliability. The furnace is also well suited to being manufactured by modern manufacturing methods at reasonable cost. The furnace is also safe and convenient.

It will be apparent to those skilled in the art that the preferred embodiment of the furnace, which has been illustrated and described, can be modified in numerous ways without departing from the spirit of the invention or the scope of the claims appended hereto.

What is claimed is:

1. An furnace for combustion of wood a other combustibles comprising:
   - a water box for containing water to be heated by the furnace;
   - a fire box disposed within said water box with a fire door opening in the fire box;
   - an air inlet means for air flow into said fire box to support combustion in the fire box;
   - at least one flue for exhausting hot combustion gases from the fire box;
   - a door for closing said fire door opening and for providing access to the inside of the fire box, said door having an inner wall for closing against said fire door opening and an outer wall spaced from said inner wall and forming an air passageway between said inner and outer walls, said inner wall having an inner wall opening through it into said fire box, and said door having at least one inlet into said passageway with said inlet offset from said inner wall opening into the fire box in the general plane of the door so ambient air flowing into said furnace

flows into said inlet, through said passageway, and through said inner wall opening into said fire box; and

a damper in said passageway at said inner wall opening into said fire box for controlling air flow into said fire box.

2. A furnace as set forth in claim 1 that also includes at least one fire tube extending generally horizontally through said fire box and opens at least one end thereof into said water box.

3. A furnace as set forth in claim 2 that also includes a plurality of fire tubes which open at both ends thereof into said water box.

4. A furnace as set forth in claim 1 such that said door to the fire box is connected to the furnace at a hinge spaced laterally of the door and said door has a toggle locking mechanism which applies substantially uniform sealing pressure of the door against the fire box around the periphery of the door.

5. A furnace as set forth in claim 4 such that said toggle locking mechanism has a vertical axis of rotation and said outer wall of said door is flexible between side edges of said outer wall and acts as a spring member for said toggle locking mechanism.

6. A furnace as set forth in claim 1 also including a flue box having an exhaust outlet and an exterior door for providing access into said flue box.

7. A furnace as set forth in claim 6 such that said at least one flue is inside said water box and connects said fire box to said flue box for passage of hot combustion gases through said firebox, said at least one flue, and said flue box.

8. A furnace as set forth in claim 7 such that said at least one flue extends for most of the length of said water box and is inclined slightly upward from horizontal toward said flue box.

9. A furnace as set forth in claim 8 wherein said at least one flue is at least two flues.

10. An furnace for combustion of wood and other combustibles to heat a fluid conducted to a remotely located heat transfer device, said furnace comprising:

a water box for containing water to be heated by the furnace;

a fire box disposed within said water box;

a door to said fire box for providing access to the inside of the fire box, said door having inner and outer walls with an air passageway between said walls;

a flue box having an exhaust outlet and an exterior door for providing access into said flue box;

at least one flue connecting said fire box to said flue box and extending generally horizontally through said water box for passage of hot combustion gases therethrough;

a plurality of fire tubes extending generally horizontally through said fire box, said tubes being open on both ends thereof into said water box for water in the water box to fill said fire tubes;

at least one air inlet into said air passageway adjacent an edge of said door and an inner wall opening into said fire box inwardly of the edges of said door for air to flow through said passageway and into said fire box to support combustion in the fire box; and

a damper in said passageway at said inner wall opening for controlling air flow into said fire box.

11. A furnace for combustion of wood and other combustibles comprising:

a water box for containing water to be heated by the furnace;

a fire box disposed within said water box;

a door to said fire box for providing access to the inside of the fire box, said door having an inner wall and a flexible outer wall spaced from said inner wall and joined to said inner wall along vertical side edges of said inner wall;

an outlet for exhaust of combustion gases from said fire box;

an inner wall opening in said inner wall for air flow into said fire box to support combustion in the fire box, and said door to the fire box is connected to the furnace at a hinge spaced laterally of the door and said door has a toggle locking mechanism which applies substantially uniform sealing pressure of the door against the fire box around the periphery of the door; and

a damper device between said inner and outer wall of said door at said inner wall opening to control air flow through said inner wall opening, said damper device comprising a damper plate pivotally mounted on said door to the fire box and a damper pull strap for connection to a temperature sensitive actuating means for moving said pull strap to open and close said damper in response to temperature changes.

12. A furnace as set forth in claim 11 such that said inner wall and said flexible outer wall define a passageway between said inner wall and said flexible outer wall for airflow through the passageway before the air enters the fire box through said inner wall opening, and said toggle locking mechanism pulls outwardly on said flexible outer wall in the closed and locked position of the door and flexes said outer wall so the outer wall acts as a spring.

13. A furnace as set forth in claim 11 such that said temperature sensitive actuating means comprises a hydrothermostat that is operated by changes in the volume of a reservoir of water caused by changes in the temperature of the water in said water box.

14. In a furnace for combustion of wood and other combustibles which has a water box, a fire box, a flue for exhaust of gaseous products of combustion, an inlet for air into the fire box and a damper for controlling air flow through said inlet, the improvement comprising a thermostat for actuating said damper hydraulically, said thermostat including a container of water in said water box in the furnace, said container of water having a diaphragm in one wall thereof responsive to changes in the volume of a quantity of water in the container, and said diaphragm is connected to said damper for operating said damper in response to changes in the volume of water in said container.

15. A furnace as set forth in claim 1 such that said at least one inlet into said passageway is adjacent the bottom of said door.

16. A furnace as set forth in claim 15 which further includes an inlet into said passageway at the top of said door.

17. A furnace as set forth in claim 5 such that said outer wall is secured to said inner wall along the vertical side edges of said inner wall so that said outer wall can flex inwardly and outwardly between said vertical side edges.

18. A furnace as set forth in claim 13 such that said hydro-thermostat comprises a pipe disposed inside said water box and said pipe has a diaphragm at each end of said piper and a burp valve adjacent the diaphragm for water to flow between the box and said pipe for filling the pipe.

19. An furnace for combustion of wood and other combustibles comprising:

a water box for containing water to be heated by the furnace;

a fire box disposed within said water box with a fire door opening in the fire box;

an air inlet means for air flow into said fire box to support combustion in the fire box;

at least one flue for exhausting hot combustion gases from the fire box; and

a door for closing said fire door opening and for providing access to the inside of the fire box, said door having an inner wall for closing against said fire door opening and an outer wall spaced from said inner wall and forming an air passageway between said inner and outer walls, said inner wall having an inner wall opening through it into said fire box, said door having at least one inlet into said passageway with said inlet offset from said inner wall opening into the fire box in the general plane of the door so ambient air flowing into said furnace flows into said inlet, through said passageway, and through said inner wall opening into said fire box, said door is connected to the furnace at a hinge spaced laterally of the door and said door has a toggle locking mechanism with a vertical axis of rotation which applies substantially uniform sealing pressure of the door against the fire box around the periphery of the door, and said outer wall of said door is flexible between side edges of said outer wall and acts as a spring member for said toggle locking mechanism.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,029,648
DATED : February 29, 2000
INVENTOR(S) : W. Coy Willis

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5,
Line 19, "16" should read -- 18 --.

Column 6,
Line 44, add spaces between -- 78, 79 --, -- 80, 81 --, and -- 82, 83 --.

Column 10,
Line 47, "An" should read -- A --.
Line 47, "a" should read -- and --.

Column 11,
Line 36, remove "at least".
Line 37, "An" should read -- A --.

Column 12,
Line 62, "piper" should read -- pipe --.
Line 63, after "between the", insert -- water --.
Line 64, "An" should read -- A --.

Signed and Sealed this

Twenty-sixth Day of February, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer

US005329920A

United States Patent [19]

Brazier

[11] **Patent Number: 5,329,920**

[45] **Date of Patent: Jul. 19, 1994**

[54] **WOOD BURNING BOILER**

[76] Inventor: **Dennis Brazier**, Rte. 1 - Box 80, Greenbush, Minn. 56726

[21] Appl. No.: **29,934**

[22] Filed: **Mar. 5, 1993**

Related U.S. Application Data

[63] Continuation of Ser. No. 799,975, Nov. 29, 1991, abandoned.

[51] **Int. Cl.**[5] **F23M 7/00; F24H 1/00**

[52] **U.S. Cl.** **126/344**; 126/193; 126/190; 122/13.1; 122/15

[58] **Field of Search** .... 126/344, 190, 198, 58 R, 126/193, 101, 116 R, 110 R, 60, 65, 67, 83; 122/13.1, 6 A, 15, 50, 68, 58 R, 73, 74, 96, 62, 107, 110; 110/234, 173 R, 173 A, 173 B, 173 C, 181

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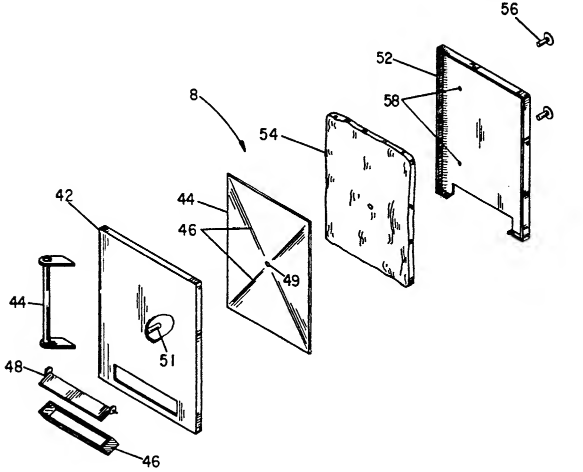
Primary Examiner—Carl D. Price

Attorney, Agent, or Firm—Douglas L. Tschida

[57] **ABSTRACT**

An outdoor, self-contained wood fueled furnace. The furnace includes a non-warping, laminated sheet metal door; a rear exiting flue with water discharge means; and a baffled, heat exchanger which surrounds the firebox. The door, particularly, includes an external panel which is secured with a single pin to a crossbroken first panel. An insulator is secured between the first panel and a second interior panel, and the first and second panels are riveted to each other.

14 Claims, 3 Drawing Sheets



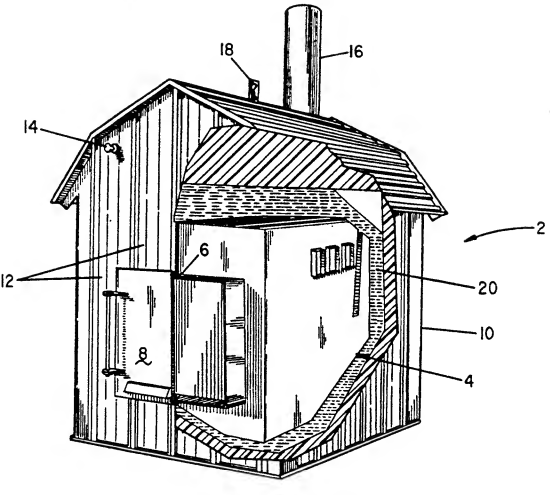


FIG. 1

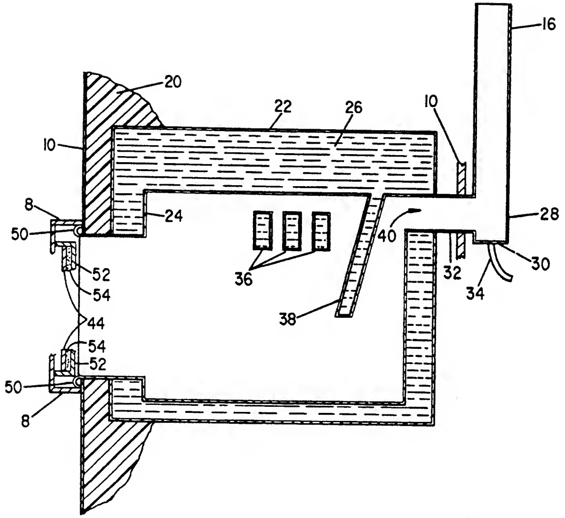


FIG. 2

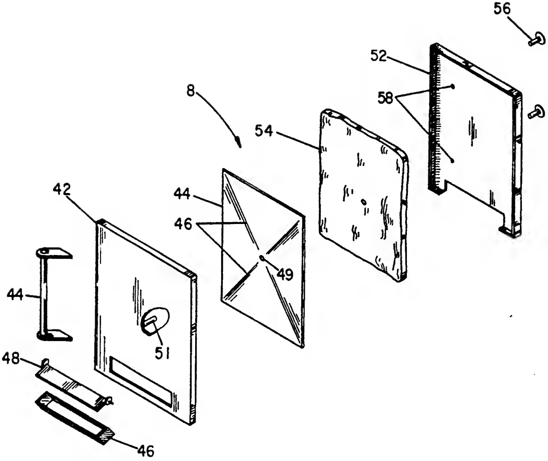


FIG. 3

WOOD BURNING BOILER

This is a continuation of application Ser. No. 07/799,975 filed Nov. 29, 1991 abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to wood or coal fueled heating systems and, in particular, to a self-contained furnace which mounts externally of the structure or premises being heated.

With increasing heating fuel costs for gas and petroleum products, alternatively fueled heating systems have experienced a resurgence in popularity. Wood and coal fired stoves, boilers and furnaces are increasingly being used as the primary or as a supplemental heat source. This is especially true in the northern-tier states where alternative, low-cost fuel supplies are available and winters tend to be long and cold.

Many of these stoves mount within the structure being heated. That is, the heating appliance is typically contained within a utility room or finished room of the dwelling. Either radiant heat is obtained or an intermediate heat exchange carrier or media is heated and conducted about the premises.

Unfortunately, the increased use of fuels that produce relatively large amounts of creosote and improper stove and flue maintenance has resulted in increased numbers of related fires and resultant increased insurance premiums. Many manufacturers of stoves and furnaces intended for use as primary heating systems, therefore, now construct there stoves as self-contained assemblies. These assemblies are mounted external to the premises to be heated. The risk of fire and smoke damage to the premises is thereby reduced.

With the removal of the firebox from the premises, larger fireboxes become more practical, along with longer burn times between each recharging or refueling. Consequently and depending upon the fuel, burn times of one to multiple days can be obtained between each re-charging of the stove. Stoves may now also be used over a longer heating season, since the residual radiant heat does not overheat the premises during milder fall or spring days. As these stoves are also made to burn more efficiently, the flue temperatures have been reduced.

With reduced flue temperatures, however, increased amounts of creosote and water vapor are created which can significantly reduce the life of the firebox, especially where a top mount flue is provided. That is, large amounts of moisture accumulate as part of the combustion process and can amount from one to many quarts a day. This water accumulates in the ash to form an acidic lye compound which corrodes away the firebox in a matter of months.

An additional problem effecting the cost of the stove and operational safety can develop at the fire door. Depending upon the stove construction, warpage can occur in the door during the normal cycling of the stove. The warpage may be significant or not and may even permanently effect the door. In all cases, however, warpage tends to create unintended drafts and unregulated burning. A non-warping door construction is therefore desired.

With the foregoing considerations in mind, applicant has developed an improved self-contained wood or coal fueled furnace.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a self-contained wood or coal fired furnace.

It is a further object of the invention to provide a furnace firebox including a laminated, non-warping door.

It is a further object of the invention to provide a firebox including a side wall exiting flue and means for preventing the collection of water within the firebox.

It is a further object of the invention to provide a firebox surrounded by a heat exchanger and a contained heat transfer medium and wherein channel ways are formed in the firebox and through which the flue gasses are conducted to extract heat to the transfer medium, as the channelways baffle the combustion gases to optimally burn all combustibles.

It is a still further object of the invention to provide a composite boiler assembly including a non-warping laminated firebox door, a water extracting flue and baffled conduits which direct combustion gases and a circulated heat transfer medium.

Various of the foregoing objects, advantages and distinctions of the invention are particularly obtained in one construction wherein a double walled furnace is mounted within a steel frame, pad mounted enclosure. The furnace includes a central firebox which is surrounded by a heat exchanger. Intermediate insulation insulates a liquid heat transfer medium and the furnace to maximize heat transfer to the medium. Associated controls regulate the burning characteristics of the furnace.

The furnace door extends from the enclosure and is hinged to the firebox. The door is constructed of a plurality of laminated, sheet metal panels which are arranged and insulated from one another to permit thermal flexing of the internal door panels, without transferring heat to an external door panel. The external panel is secured to a crossbroken middle panel which is supported at a center truss pin to the external door panel. An innermost panel, otherwise, is separately retained to the middle panel via a minimal number of fasteners. An insulation barrier mounts between the middle and internal panels.

An exhaust gas flue extends from a side or rear wall of the firebox through a surrounding heat exchanger containing a water based heat transfer medium. A drip-tee having a waste port directs water formed within the flue away from the firebox.

The heat exchanger includes a plurality of hollow, horizontal conduits or baffles which are directed through the firebox and above the fire and wherethrough the heat transfer medium is channeled to extract heat. An additional full width, planar channelway projects from a top wall of the firebox intermediate the space between the fire and the flue to further recirculate flue gas and extract heat from the exhaust gases.

Still other objects, advantages and distinctions of the invention will become more apparent from the following description with respect to the appended drawings. To the extent various modifications and improvements have been considered, they are described as appropriate. The following description should not however be interpreted in limitation of the invention, which rather should be interpreted within the spirit and scope of the following presented claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective drawing shown in partial cutaway of a self-contained boiler construction of the present invention.

FIG. 2 is an elevation drawing shown in cross section of the firebox and surrounding water chamber and wherefrom details of the baffling and flue mounting are apparent.

FIG. 3 is a perspective drawing shown in exploded assembly of the laminated door construction.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a perspective drawing is shown in partial cutaway of the improved wood or coal fired furnace 2 of the present invention. The furnace is normally mounted a short distance from a premises to be heated. The furnace 2 comprises a multi-walled, wood or coal fueled stove 4. A central firebox is surrounded by a heat exchanger containing a water based heat transfer medium. Alternatively, an air-to-air exchanger or other types of heat exchangers could be coupled to the firebox.

Attendant conduits or piping are mounted below grade and convey the water or a water-glycol mixture between the furnace 2 and the heated premises. Glycol is added to prevent freeze-up, should circulation be interrupted. A circulator motor mounted within the premises, conveys the water based heat transfer medium between the two structures. A temperature controller within the premises typically regulates liquid flow via controlled gate valves. This controller may or may not be coupled to a separate controller at the furnace.

Extraneous pathways may also be provided in the conduit system to bleed-off undesired heat during mild heating days. Such pathways permit continuous circulation of the coolant, which if otherwise allowed to remain stagnant, could freeze below grade or otherwise cause a bursting of the conduits.

A separate temperature controller (not shown) at the furnace 2, otherwise, monitors the water based transfer medium to maintain a temperature of approximately 170 degrees. A motorized damper control (not shown) is coupled to a damper 48 (reference FIG. 3) to regulate combustion air to the firebox. Proper control requires an airtight or relatively constant seal 6 at the juncture between the access door 8 and the firebox. Temporary or permanent warpage of the door 8, which can occur with relatively hot fires, can upset the regulation.

Any door mounted in close association to the fire, such as a cast iron door, tends to expand and contract in harmony with the firebox and permanent warpage does not normally occur. Cast iron doors, however, are relatively costly. Permitting the door to cycle with the firebox temperature also compromises furnace safety, especially to the unwary fire tender or passer by. Use of a cast door in an external setting further exposes the door to rusting, which occurs with the cycling of the stove in a humid environment.

The foregoing deficiencies suggest use of a formed sheet metal door. However, unless such a door is allowed to cycle with firebox temperatures, a separate safety or cover door is typically required. Sheet metal doors are also prone to permanent warpage. Although warpage may not occur with smaller stoves, larger furnaces 2 of the present type, which burn for an entire day or several days between chargings, are more susceptible to warpage. An improved, laminated door construction is thus provided with the furnace 2 of FIG. 1. Other improvements are also provided which are discussed in greater detail with respect to FIGS. 1 to 3.

Before addressing the particular improvements of the furnace assembly 2, the stove 4 is integrally mounted within a surrounding enclosure 10. The enclosure 10 is fabricated from painted steel panels 12 such as are commonly used in pole barn construction. In normal use, the furnace 2 can either be mounted on a pad or a prepared sand or gravel base.

A night light 14 is mounted to the front of the enclosure 10 to facilitate tending during low light conditions. A flue 16, otherwise, projects through the rear wall of the enclosure, along with a lifting or transport flange 18. A separate weather cap is not typically required at the flue 16 and the reasons for which will become more apparent.

Otherwise, the interior space of the enclosure 10 is filled with an expandable urethane foam 20. Once applied, the foam expands to completely fill the enclosure interior and conforms to the mounted stove 4. Because a double-walled stove construction is used and wherein a liquid heat exchanger surrounds the firebox, the foam 20 can directly contact the heat exchanger and the temperature of which does not exceed the nominal fire rating of the foam.

With attention to FIG. 2, more of the internal details of the stove construction and the mounting between the stove 4 and enclosure 10 are apparent. The stove 4, as mentioned, is particularly constructed in a double-walled configuration. That is, a water-tight, external housing 22 surrounds an internal water-tight firebox 24. The cavity 26 between the housings 22,24 contains a water based liquid heat transfer medium which is piped through the structure (not shown) being heated. The walls of the housings 22 and 24 are respectively constructed of seven gauge and ¼ inch steel sheet stock. A firebrick liner may be provided at the bottom of the firebox 24, if the heat exchanger housing 22 doesn't surround the bottom of the firebox 24. Ash removal and combustion air occur through the front access door 8.

The flue 16 projects horizontally through a rear wall of the firebox 24, heat exchanger 22 and enclosure 10 to a T-coupler 28, where the flue is vertically redirected upward. The bottom 30 of the T-coupler 28 is disposed below the horizontal flue section 32. A drain port 34 is positioned at a low point of the coupler 28 and from which a length of hosing or conduit 36 may extend to bleed-off water which is formed during combustion or which might enter the flue 16 during rain or snow conditions.

Nominal quantities from a pint to a gallon or more of liquid can be created on a daily basis with the present furnace 4. If the liquid is allowed to return to the firebox 24 and mix with the ash, the firebox 24 can prematurely corrode through within a matter of one to two years. Appreciating the sealed construction of the furnace 2, the facility to drain combustion water away from the stove 4 is therefore especially critical.

Also formed into the walls of the firebox 24 are a plurality of baffles. Three horizontal baffles 36 are provided which extend through the sidewalls of the firebox 24 and which overlay the fire. The heat transfer medium circulates thorugh these baffles.

An additional planar baffle 38 angulates downward and inward between the exhaust port 40 of the flue 16

and the interior of the firebox 24. Prior to exiting the firebox 24, flue gases are normally circulated about the horizontal and planar baffles 36 and 38 to enhance the burning of all combustible particulates and gases and to extract optimal heat from the gases prior to exiting the flue. The overall efficiency of the furnace per charging is thereby enhanced.

With attention next directed to FIG. 3, a detailed perspective drawing is shown in exploded assembly of the laminated access door 8. The door 8 is particularly constructed of a seven gauge external door panel 42, which includes an access handle 44 and an associated combustion air port 46 and pivotally mounted damper 48. The internal periphery of the door contains a fireproof seal 50 (reference FIG. 2). Upon closing the door 8, the seal 50 contacts the periphery of the access port to provide an airtight seal to the firebox 24.

Coupled to the exterior panel 42 is a middle panel 44. The panel 44 is formed of a thinner gauge sheet metal and includes a pair of diagonal or crossbroken bends 46 which extend diagonally between the corners. A center hole 48 at the intersection of the bends 46 receives a truss pin 51 (shown in cutaway) which extends from an inner surface of the external panel 42. Upon mounting the center panel 44 over the truss pin 51 at the center hole 49, the truss pin 51 is flattened over an intervening washer (not shown). The center panel 44 is thereby riveted to the external door panel, but in a rather loose mounting.

The center panel 44 partially stabilizes the external panel 42, but more importantly, thermally insulates the external panel 42 from the relatively hot temperatures of the firebox 24 via the intervening air. A minimal number of connections between the middle panel 44 and external panel 42 minimize heat transfer and permit maximum flexing and thereby prevent door warpage.

Mounted between the aft surface of the middle panel 44 and an interior door panel 52 is a layer of a woven, ceramic impregnated insulator 54. The material is approximately ⅜" thick.

The door panel 52, otherwise, is formed to encase the insulator 54 and the middle panel 44 without being permanently connected to the external door panel 42. The inner and middle door panels 52, 44 are secured to one another with a pair of rivet fasteners 56 which are welded to the aft surface of panel 44 and extend through a pair of holes 58 provided on one side of panel 52, where they are flattened. Heat transfer and any potential warpage of the external door panel 42 is thus further prevented via the insulator 54 and the limited number of direct couplings between the panels 44, 52. In normal use, the foregoing laminated construction assures that the external panel 42 remains cool to the touch, thus satisfying safety concerns along with the equally important cost and corrosion concerns earlier mentioned.

Singularly and in combination, the foregoing door 8, flue 16 and baffles 36 and 38 provide a long-lived energy efficient stove 4. Although described with respect to a boiler configuration, it is to be appreciated that the improvements may also be utilized with a forced air furnace. Similarly, the individual improvements can be singularly incorporated into other stove constructions.

While the invention has accordingly been described with respect to its presently preferred construction and various modifications and improvements thereto, it is to be appreciated still other constructions may suggest themselves to those skilled in the art. Accordingly, the following claims should be interpreted to include all those equivalent embodiments within the spirit and scope thereof.

What is claimed is:

1. Heating apparatus comprising:

a) stove means having a plurality of side, top and bottom walls, wherein said walls enclose a first cavity and wherein at least one of said walls included an access port to the first cavity and at least one of said walls includes an exhaust port to the first cavity, for containing a fire within the first cavity;

b) heat exchange means having a plurality of walls secured to and surrounding said stove means to define a second cavity for containing a thermal transfer medium to contact the walls of said stove means without communicating with said access and exhaust ports;

c) door means for covering said access port and comprising 1) an external metal panel, 2) a first metal panel, wherein portions of said first and external panels subtend an air space between the first and external panels, 3) a second metal panel, 4) an insulator layer mounted between the first and second panels, 5) first fastener means for restraining said first panel to said external panel, 6) second fastener means offset from said first fastener means for restraining said first panel to said second panel, and 7) wherein at least one of said first and second fastener means comprises a pin which projects from one of the external or first panels and loosely extends through an aperture at the other of the first or second panels, such that the other of the first and second panels flexes along said pin with thermal changes in said first cavity, whereby said external, first and second panels are substantially thermally insulated from one another and said first and second panels are able to flex independent of one another without transfering panel flexion to cause warpage of the external panel; and

d) flue means communicating with said exhaust port for exhausting combustion gases.

2. Apparatus as set forth in claim 1 wherein said first panel is rectangular and includes first and second bends, which intersect, and which extend between opposite diagonal corners of said first panel, wherein a first pin extends from the external panel through an aperture at the intersection of the bends, and wherein second and third pins extend from the first panel through a pair of apertures at the second panel.

3. Apparatus as set forth in claim 2 wherein peripheral edges of said second panel subtend said first panel.

4. Apparatus as set forth in claim 2 including a multiwalled, steel frame enclosure mounted to surround said heat exchange means, except in the region of said door means and said flue means, and wherein a thermal insulator mounts between said enclosure and said heat exchange means.

5. Heating apparatus comprising:

a) stove means having a plurality of side, top and bottom walls, wherein said walls enclose a first cavity and wherein at least one of said walls includes an acess port to the first cavity and at least one of said walls includes an exhaust port to the first cavity, for containing a fire within the first cavity;

b) heat exchange means having a plurality of walls secured to and surrounding said stove means to define a second cavity for containing a thermal

transfer medium to contact the walls of said stove means without communicating with said access and exhaust ports;

c) door means for covering said access port and comprising 1) an external metal panel, 2) a first metal panel including first and second intersecting bends, 3) a first pin extending from the external panel and through a first aperture at an intersection of the bends panel and wherein the first panel subtends an air space between the first and external panels, 4) a second metal panel having second and third apertures, 5) an insulator layer mounted between the first and second panels, 6) second and third pins offset from said first pin and extending between the first and second panels through said second and third apertures, and 7) wherein at least one of the first and second panels flexes along said first, second or third pins with thermal changes in said first cavity, whereby said external, first and second panels are substantially thermally insulated from one another and said first and second panels are able to flex independent of one another without transferring panel flexion to cause warpage of the external panel; and

d) flue means communicating with said exhaust port for exhausting combustion gases.

6. Apparatus as set forth in claim 5 wherein peripheral edges of said second panel subtend said first panel.

7. Apparatus as set forth in claim 5 including a multi-walled, steel frame enclosure mounted to surround said heat exchange means, except in the region of said door means and said flue means, and wherein a thermal insulator mounts between said enclosure and said heat exchange means.

8. Heating apparatus comprising:

a) stove means having a plurality of side, top and bottom walls, wherein said walls enclose a first cavity and wherein at least one of said walls includes an access port to the first cavity and at least one of said walls includes an exhaust port to the first cavity, for containing a fire within the first cavity, wherein a plurality of conduits extend through the first cavity above a fire space, wherein each conduit has a bore exposed through one of said side walls, and wherein the top wall includes a recess which extends into the first cavity in a space between said conduits and the exhaust port;

b) heat exchange means having a plurality of walls secured to and surrounding said stove means to define a second cavity for containing a thermal medium to contact the walls of said stove means and to flow through the bore of each of said conduits without communicating with said access and exhaust ports;

c) door means for covering said access port and comprising 1) an external metal panel, 2) a first metal panel, 3) a second metal panel, 4) means for thermally insulating said external panel from said first panel and the first panel from the second panel, 5) first fastener means for restraining said first panel to said external panel, 6) second fastener means offset from said first fastener means for restraining said first panel to said second panel, and 7) wherein at least one of said first and second fastener means comprises a pin which projects from one of the external or first panels and loosely extends through an aperture at the other of the first or second panels such that the other of the first an second panels flexes along said pin with thermal changes in said first cavity, whereby said external, first and second panels are substantially thermally insulated from one another and said first and second panels are able to flex independent of one another without transfering panel flexion to cause warpage of the external panel; and

d) flue means communicating with said exhaust port for exhausting combustion gases and including means for removing liquids formed within said flue means.

9. Apparatus as set forth in claim 8 wherein said first panel includes a plurality of bends.

10. Apparatus as set forth in claim 9 wherein said first panel is rectangular and includes first and second bends which extend between opposite diagonal corners of said first panel and wherein a single pin fastener couples said first panel to said external panel at an intersection of the first and second bends.

11. Apparatus as set forth in claim 8 wherein the liquid removal means comprises a T-shaped coupler having a liquid discharge portion which mounts below the exhaust port.

12. Apparatus as set forth in claim 8 including damper means coupled to said door means for controllably admitting combustion air to said first cavity.

13. Apparatus as set forth in claim 8 including a multi-walled, steel frame enclosure mounted to surround said heat exchange means, except in the region of said door means and said flue means, and wherein a thermal insulator mounts between said enclosure and said heat exchange means.

14. Apparats as set forth in claim 8 wherein said thermal transfer medium comprises water.

* * * * *

United States Patent [19]
Cleer, Jr.

[11] **4,025,043**
[45] **May 24, 1977**

[54] **FIREPLACE HEATING SYSTEM**

[75] Inventor: **Clarence W. Cleer, Jr.**, Kane, Pa.

[73] Assignee: **Ridgway Steel Fabricators, Inc.**, Ridgway, Pa.

[22] Filed: **May 18, 1976**

[21] Appl. No.: **687,631**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 495,107, Aug. 5, 1974, Pat. No. 3,958,755.

[52] **U.S. Cl.** .... 237/53; 126/101; 126/132; 126/121; 237/8 R

[51] **Int. Cl.²** F24D 5/00; F24D 9/00

[58] **Field of Search** .... 126/101, 121, 110 R, 126/132, 164, 153, 154, 143, 133; 237/51, 53, 16, 8 R

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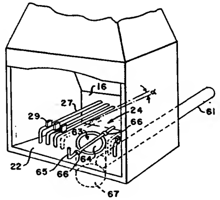
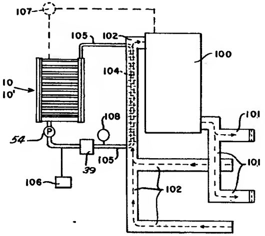
Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney, Agent, or Firm—Cushman, Darby & Cushman

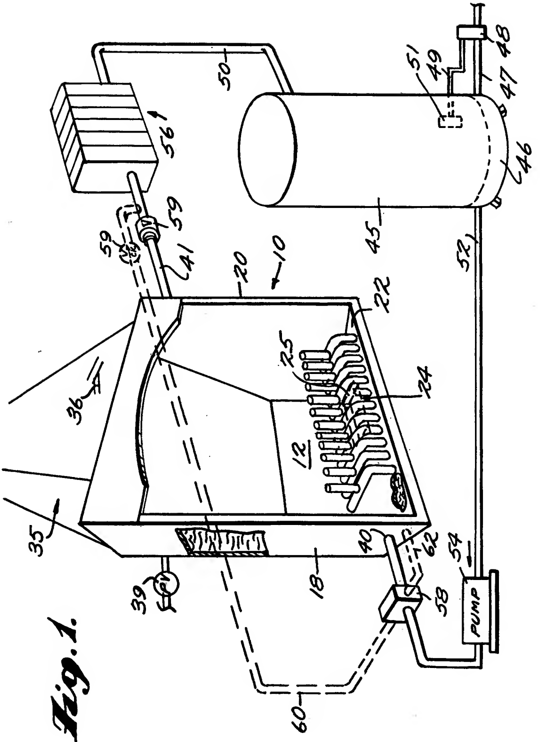
[57] **ABSTRACT**

A heating system for heating a confined area with an open-hearth wood-burning fireplace. A fireplace jacket is provided which comprises a multi-chambered double-walled arrangement or a grate member. Log supporting portions of the jacket slant upward slightly in order to prevent a pinging sound by creating convectional force when water is circulating therethrough. The grate member includes first and second headers formed from prisms with triangular bases, and water conducting pipe portions extending on three sides of a fire burning in the open-hearth fireplace. The fireplace jacket is readily utilizable with a conventional forced-air furnace in association with a heat exchanger disposed in the furnace cold air return. Combustion air for the fire is provided from an area external of the confined area to be heated by the heating system.

9 Claims, 9 Drawing Figures






10
12
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39
PV
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41
45
46
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48
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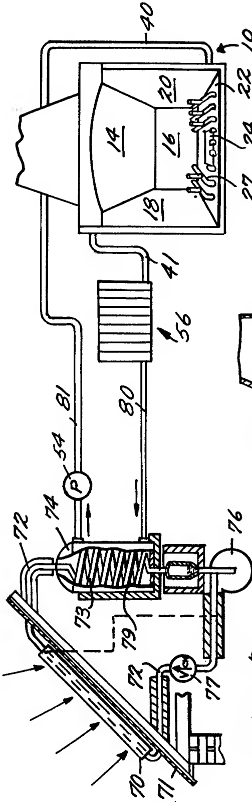
51
52
54
PUMP
56
58
59
60
62

Fig. 1.



40
10
20
22
14
16
24
27
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56
81
80
54
P
72
74
76
73
79
72
77
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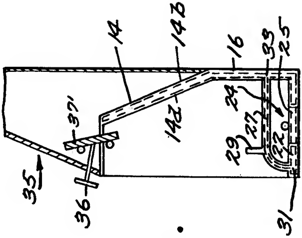
71

Fig.3.



14
14B
16
33
25
37'
14A
24
27
29
22
35
36
31

Fig.2.

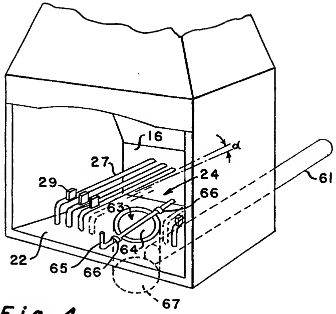


Fig. 4

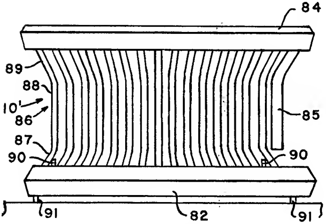


Fig. 5

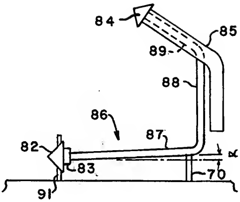


Fig. 6

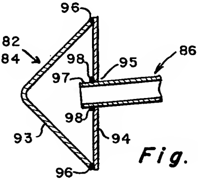


Fig. 7

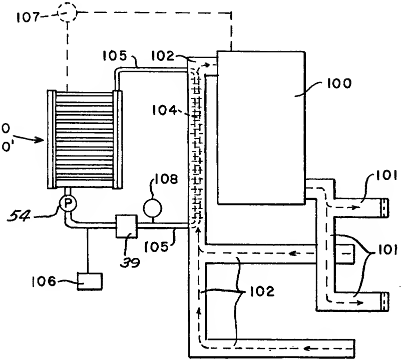

107
105
102
100
104
10
10'
108
101
54
39
105
101
106
102

Fig. 8

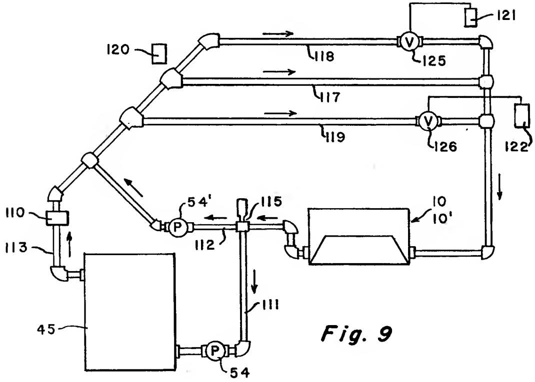

121
120
118
125
117
119
126
122
54'
115
10
10'
110
112
113
111
45
54

Fig. 9

FIREPLACE HEATING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of U.S. Ser. No. 495,107 filed Aug. 5, 1974 entitled "Hydro-Thermo Fireplace and Heating System Therefor", now Pat. No. 3,958,755.

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates to a means for heating a building or for heating hot water for the building comprising in part a means adapted to use the heat from an open woodburning fireplace. In the past, it has been generally known to use the heat from a fireplace to heat water passed around the open fire - such as shown in U.S. Pat. No. 219,978, 670,066, 1,352,371; 1,432,538; and 2,113,896 — however, none of these systems has been useful as an auxiliary in homes with conventional heating or hot-water heating systems, nor have any of these devices provided as great an area for heat transfer as the device of the present invention.

With depletion of our natural resources of oil and natural gas, and with increasingly higher electricity prices it is becoming more and more practical to use wood burned in an open fire as a heat source. In addition to having the potential of meeting a large portion of a home's heating requirements, open wood-burning fireplaces are decorative and often serve as a focal point for family activities. However, it is usually impractical to assume, as have many prior art devices, that wood burned in an open fireplace can provide all the heating or hot-water heating requirements of a home since a fire must be constantly attended to and since large quantities of wood are impractical to store in most homes and locations. However, according to the teachings of the present invention, such a fireplace if hooked up with the conventional heating (including a forced-air system) or forced hot-water heating systems of a home can supply a good deal of auxiliary heat, and can thereby save on utility bills and reduce consumption of difficult to obtain natural resources while providing aesthetic appeal as well.

According to the heating system of the present invention, a water jacket is utilized for circulating water directly around an open-hearth fire. The jacket may comprise a double-walled member having chambers disposed on five sides of the fire and having log-supporting water conducting pipes, or a grate member having water-conducting pipe portions for supporting wood thereon, in each case the wood-supporting members slanting slightly upwardly to create a convectional force so that no pinging sound results from inadequate circulation of water through the wood-supporting members when a fire is burning. Water coming in through an inlet is circulated through the jacket and absorbs heat from the fire burning within the fireplace, and then the hot water by convection rises to the discharge area and passes out a water outlet. The bottom chamber of the multi-water chamber version of the jacket, has an opening formed therein in order to provide combustion air to the fire and increases the heating capability thereof, while additionally reducing materials expense, without interfering with water circulation through the jacket. The opening preferably is connected to the outside of the area to be heated (exterior wall) so that make-up air for the fire is provided from the outside, and not by air preheated by the conventional heating system. A damper may be provided over the combustion air opening for controlling the amount of combustion air that is admitted thereby.

The metal water jacket inlets and outlets are connected up with the conventional pipes of the heating or hotwater heating system of a building, a conventional pump circulating water from the fireplace through the radiators and water storage tank, and interconnecting pipes thereof. A means is provided responsive to the temperature within the hot water storage tank for cutting off the fuel supply (or other means essential to heating of the water by conventional means) when the temperature of water in the tank reaches a certain level due to heating thereof by the fireplace. In addition, means may be provided for cutting out the fireplace from the water circulating system when it is not desired to use the fireplace, or else the fireplace may be left in the system to act as a radiator. The fireplace may be hooked up with solar heating systems, gas burning ones, fuel oil ones, or electric heating systems, and means may be provided for modifying the system to provide forced air heating instead of water heating. For instance, the jacket can communicate with a heat exchanger disposed in the cold air return of a conventional forced air furnace, a circulating pump, expansion tank, and pressure relief valve also being associated therewith. It will be seen that according to the present invention a wood-burning heating system is provided that is an integral operative conjunction with any type of conventional heating system except baseboard electric.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective diagrammatic view of a heating system according to the present invention;

FIG. 2 is a cross-sectional view of the water jacket shown in FIG. 1 taken along lines 2—2;

FIG. 3 is a view of another heating system according to the present invention, showing one portion of the heating system in partial cross-section and a front view of the water jacket;

FIG. 4 is a perspective view of another embodiment of the water jacket of FIG. 1, with portions thereof cut away for clarity;

FIG. 5 is a front view of a grate member water jacket according to the present invention;

FIG. 6 is a side view of the jacket of FIG. 5;

FIG. 7 is a cross-sectional detail view of one of the headers of the grate member of FIGS. 5 and 6;

FIG. 8 is a schematic view of a heating system according to the present invention utilizing conventional forced-air ducts; and

FIG. 9 is a schematic view of a heating system according to the present invention for three-zone control, associated with a domestic hot water supply.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a heating system for a building including a conventional heating system and a jacket 10 for an open-wood-burning fireplace according to the teachings of the present invention. The jacket 10 defines a fireplace 12 in the interior thereof, the fireplace 12 being confined on all sides by the jacket 10 and chimney means 35 associated therewith except for an open front.

The jacket 10 comprises a top portion 14 (see FIGS. 2 and 3 especially), a back portion 16, side portions 18 and 20, and a bottom portion 22. Each of these portions includes spaced metal wall members (i.e., 14*a*, 14*b*) defining a water holding chamber therebetween. Although the dimensions may be varied depending upon the total size of the fireplace and building in which it is located, it is preferred that the walls forming each of the chambers 14, 16, 18, 20 and 22 be spaced approximately 1 7/16 inches apart. Note too that it is preferred that the walls of side chambers 18, 20 slant back so the jacket may be easily fit into an area of a building wall adapted to receive a fireplace. Any wall configuration may be adapted that will increase functional and aesthetic value, or the fireplace 12 may be free standing.

Within the fireplace 12 are disposed a plurality of L-shaped hollow grate members 27. Each member 27 has a solid upstanding rod portion 29 thereof adapted to retain logs on the long leg of the members 27, and each member is connected at 31 to the bottom water chamber 22 and at 33 to the back chamber 16. The members 27 may also be connected to the side chambers 18, 20, if desired. Note that free communication is provided between all the chambers 14, 16, 18, 20 and 22 and the interiors of the grate members 27. As shown in FIG. 4, it is desired that the long legs of the wood-suporting members 27 extend upwardly at a slight angle, rather than just being horizontal. As shown in FIG. 4, the long legs of members 27 make a positive angle α of greater than 0° with the horizontal, preferably α = 1°–2°. When the long legs of members 27 are horizontal rather than being disposed at a slight positive angle α, a "pinging" sound is created when water is flowing through the members 27 with a fire burning in the fireplace 12, which pinging sound can be quite loud at times, and is often objectionable. When the members 27 are arranged as shown in FIG. 4, however, with the long legs thereof disposed at a slight positive angle α, this pinging sound is eliminated by increasing convectional flow in the grate members.

Although any suitable heat-conducting material is suitable for forming the structural components of the jacket 10, preferably all the walls of all the chambers will be formed of plate steel, the individual wall portions being welded together at the interfaces thereof. The hollow grate members 27 are preferably made of steel pipe.

Formed in the bottom chamber 22 is an opening 24. The opening 24 is defined by wall portions 25 of the bottom chamber 22, and it provides a combustion air intake. The provision of this combustion air intake 24 increases the efficiency of the burning in the fireplace and thus the heat transfer to the water within the chambers. It is preferred that this combustion air intake 24 is connected to a source of combustion air outside the confined area to be heated by the fireplace 12. The reason for this is that if inside air, previously heated by the conventional heating system for the house or the like in which the fireplace 12 is disposed, is used to support combustion of the fire, the warmed air is passed up the chimney and is wasted, and cold air must be drawn through the windows, doors, and cracks, etc. of the home in order to provide make-up for the air passing up the chimney. Thus, the utilization of a fireplace may actually result in a net heat loss for a home with a conventional heating system when inside air is provided for the combustion air. According to the present invention, when air from an area outside the confined area to be heated by the heating system (i.e., outside) air is utilized this problem is avoided, and a maximum benefit is achieved from the use of the fireplace 12 in conjunction with the conventional heating system. Further, with modern construction methods and materials it is possible to build said confined area in such a manner that it is virtually airtight. Consequently, if no specific provision is made for supplying the fire with combustion air from outside the confined area it is possible that the fireplace would not draft properly, thereby creating a safety hazard.

As shown in FIG. 4, the connection of intake 24 to the outside may be effected merely with a conduit in communication with the intake 24 and extending through the walls of the house or the like in which the fireplace 12 is disposed to the outside. Also, a damper 63 may be provided (see FIG. 4) over the intake 24, the damper including a plate 64 attached to means for adjustably controlling the position of the plate 64, such as control arm 65, the control arm 65 being received by brackets 66 connected to the bottom chamber 22 of the jacket 10 and mounting the arm 65 for pivotal movement about a horizontal axis. The opening 24 additionally can serve as an ash disposal, an ash chute 67 or the like being connected thereto.

It will be appreciated that the jacket of the present invention provides for maximum transfer of heat from the fire to the water in the water chambers surrounding the fire since water is circulating on all sides (five) except the open front of the fireplace, and since there is free communication between all of the chambers. Also, since the water inlet 40 is disposed at the bottom of one of the chambers (18 in FIG. 1) and water outlet 41 is disposed at the top of a chamber opposite to the chamber of the water inlet (20 in FIG. 1), water must be significantly heated by moving past the fire on all sides thereof before it is moved up to the outlet by natural convection. Although prior art proposals (see FIGS. 7 and 11 of U.S. Pat. No. 1,352,371 for instance) have suggested that water be circulated within a grate and around several sides of a fire, none of the prior art proposals contemplates an open wood-burning fireplace surrounded on five sides thereof closely adjacent to the fire with freecommunicating water conducting chambers and with water circulating through hollow grate portions and with an opening in the bottom chamber for more complete combustion and efficiency, as taught by the present invention.

Located on top of the water jacket 10 is a chimney means 35 which is attached to the top and side chambers (14, 18, 20) of the jacket 10 at various portions thereof and provides for removal of the combustion gases within the fireplace 12. Located within the chimney means 35 is a conventional damper 37 operated by a conventional control handle 36 thereof, which handle extends to the exterior of the chimney means 35 for easy operation thereof. However, the damper control arm may be disposed to the interior opening of the fireplace for more convience in manufacturing and operation.

An alternative form of fireplace jacket for circulating water directly around an open-hearth wood-burning fireplace adapted to have an open fire therein is shown generally at 10' in FIGS. 5 and 6. The jacket 10' includes a grate member having a first header 82 having a liquid inlet 83 connected thereto, a second header 84 having a liquid outlet 85 connected thereto, and a plu-

rality of liquid conducting pipes shown generally at 86, extending between the first header 82 and the second header 84. The inlet 83 may be connected to pipe 52 in the FIG. 1 system, and outlet 85 connected to pipe 41 in the FIG. 1 system. The liquid conducting pipes have wood supporting generally horizontally extending portions 87 extending from the first header 82 toward the second header 84, generally vertically extending portions 88 connected to the wood-supporting portions 87 and forming a back of the jacket 10', and slanting portions 89 connected to the portions 88 and extending vertically and back toward the first header 82, the portions 88 being connected to the second header 84 in liquid communication therewith. Thus liquid is circulated on three sides of the fire. While the wood supporting portions 87 are referred to as "generally" horizontally extending, in fact it is necessary that these portions 87 slant upward slightly (just as do the long legs of members 27, as shown in FIG. 4) in order to eliminate a pinging sound by creating a convectional force as the water circulates therethrough with a fire burning in the fireplace. The portions 87 make a positive angle α with respect to the horizontal (see FIG. 6) that is greater than 0° — about 1 – 2°. Means are provided for supporting the log supporting portions 87 so that they are disposed at the angle α, and such means may take the form of a pair of legs 90 spaced from the first header 82 and connected to some of the water conducting pipe portions 87. Small legs 91 can also be provided for supporting the first header 82, of course the relative lengths between the legs 90, 91 being selected so that the small positive angle α for the portions 87 is achieved.

The headers 82, 84 — in order that they may be manufactured in the least expensive way possible — are formed as prisms with generally triangularly shaped bases. As shown most clearly in FIG. 7, a bent plate member 93 formed two legs of the triangular base of the prism, while a straight plate member 94 having a plurality of holes 95 formed therein along the length thereof forms the third leg of the triangular base, the straight plate member 94 being connected to the bent plate member 93 by welds 96 or the like. When formed in this way, the headers 82, 84 may readily be made by a stamping operation and with an automatic tube welder — rather than requiring complex tooling — the straight plate member 94 merely being punched and then connected up to the bent plate member 93, after the liquid conducting pipes 86 (and the inlet 83 or outlet 85) are connected thereto. Each liquid conducting pipe 86 has a free end 97 thereof passed through an opening 95 formed in straight plate member 94, and then the free end 97 is connected by weld 98 on the "inside" of the straight plate member 94 to the member 94. In this way a structurally sound, water-tight, structure is readily constructed in an inexpensive manner from commonly existing materials.

The outlet pipe 41 of the jacket 10 is connected to means for radiating the heat from the water conducted thereby to various rooms in the building in which it is used - such as radiator(s) 56 — and from there is conducted by suitable means such as pipe 50 to a conventional hot-water storage tank 45 of a conventional heating or hot water system. It is understood that instead of radiators 56 a suitable forced air means blowing over hot water conducting coils could be used as the heat transfer means. As shown in FIG. 1, the water tank 45 has a means shown diagrammatically at 46 thereof for heating the water within the tank 45. The means 46 is supplied with fuel or power from a conventional source, such as fuel oil, natural gas, or electricity, through a means 47. A cutoff means 48 is placed within the power or fuel supply 47 and is operatively connected by 49 to a means 51 within the water tank 45 that is responsive to the temperature within the tank 45. When the temperature within the tank is sufficient so that enough heat is being supplied by radiator(s) 56 to the respective areas of the building to be heated — such as when the fireplace 12 has a fire burning therein and water is circulating through the jacket 10 — cutoff means 48 will cutoff the supply of fuel or power to the heater 46 so that it will not operate to further raise the temperature within the tank 45.

Water from storage tank 45 passes through outlet 52 to a conventional pump 54 to be circulated through the jacket 10 and through the system as a whole. The pump 54 provides the motive force for circulating the water throughout the entire heating system (convection of water in the jacket 10 will not be enough to adequately circulate the water throughout the whole system), and may be connected at any suitable location within the heating system. As shown in the drawings, it is connected to the inlet 40 of the jacket 10.

Preferably, water is normally circulating through the jacket 10 (or 10') and the entire heating system at about 12–20 psi. As a safety measure, a pressure relief vent 39 is provided in jacket 10 to prevent too high a build-up of pressure within the jacket 10 which might result in rupturing thereof. Although the welded-steel jacket 10 of the present invention is much more pressure-tight and blowout proof than the cast iron water circulating means of prior art devices, since rupture of the jacket 10 might result in scalding of an individual in the vicinity of the fireplace 12, and since there is no simple means of "turning down" the fire within the fireplace 12 without completely extinguishing it, a pressure relief such as 39 is desirable. The pressure relief 39 is preferably adapted to vent at 30 psi, venting being provided to the exterior of the building or any other suitable place, such as a storage tank, etc.

When it is not desirable to use the fireplace 12 but rather to supply the complete heat or hot water needs of a building with the conventional means 45, 46, a valve 58 may be provided in the inlet 40 for the jacket 10 for cutting off the flow of water therethrough, and simultaneously cutting in a by-pass circulating system 60. In conjunction with this, check valves 59 may be provided in the outlets of the system 60 and the pipe 41 so that water flowing from one system cannot go through the other.

The valve 58 may be operated by any suitable means — for instance, it may be manually operated, or it may be connected through 62 to a temperature responsive means within the jacket 10 which activates the valve 58 when the temperature within the jacket 10 is lower than a certain amount (such as would result when there was no fire burning therein). It is sometimes desirable to cut off the jacket 10 from the circulating system since it contains a large volume of water that must be heated by the means 46; however, since it may also act as a radiator even when a fire is not burning therein, it is not always desirable to employ a cutout such as valve 58 when the fireplace 12 has no fire burning therein. Of course, a supply of make-up water can be provided for the system as a whole or any of the component parts thereof.

In addition to being connected up to a conventional heating or hot water system, the jacket **10** (or **10'**) according to the present invention could be connected up to any other heating or hot water means, such as a solar heating unit. Any suitable solar heating unit may be so provided as a secondary heating means, such as those shown in U.S. Pat. Nos. 3,390,672; 3,254,703 and 3,254,702. An exemplary suitable solar heating or hot water unit is shown in FIG. **3**. This includes a solar collector **70** mounted on a roof **71** of a building, said collector having water-conducting pipes extending therethrough and connected to pipes **72** communicating therewith. The pipes **72** are formed as a coil **73** to increase heat-transfer therefrom within water storage tank **74**. Water may be pumped through the system by a pump **76**, through a check valve **77** (to keep the water from draining out of the solar collector **70** when the pump **76** is not operating), and the pump **76** is preferably controlled by a means **79** responsive to the water temperature within the tank **74** and/or the solar collector **70**. Thus, just as with the FIG. **1** embodiment, when the temperature in tank **74** reaches a certain degree as a result of heating of water by the fireplace **14**, the pump will be cut out, and water circulation through the solar collector **70** terminated. Other cut-off means could be provided for the solar system, such as a cut-off valve in pipe **72**.

The water jacket **10** is operatively connected to the solar system by pipes **80** and **81** respectively leading into and from the water storage tank **74**. Again, conventional pump **54** and radiator(s) **56** are provided as may be suitable means for cutting out the jacket **10** from the water-circulating system if desired.

A heating system according to the present invention may also be provided in a home with a conventional installed forced-air furnace, such as gas or electric forced-air furnaces. This heating system is shown in FIG. **8**. The conventional forced-air furnace **100** has hot air ducts **101** extending thereform, and cold air returns **102** extending thereto. A fireplace jacket **10** or **10'** comprising means for circulating water or a like liquid around an open-hearth wood burning fireplace adapted to have an open fire therein is provided, the jacket **10** or **10'** including wood supporting water-conducting pipe portions (see **27** in FIG. **4**, and **87** in FIG. **6**) and means for supporting said wood supporting water conducting pipe portions so that they make a positive angle of greater than 0° with respect to the horizontal (see back **16** in FIG. **4** and legs **90** in FIG. **6**). A powered pump **54** is provided and a heat exchanger **104** — which may be of any conventional type — is provided disposed in the cold air return **102**. Pipes **105** provide means for operatively connecting the pump **54**, fireplace jacket **10** or **10'**, and heat exchanger **104** in a generally closed loop to circulate liquid through the jacket **10** or **10'** to be heated, and then to the heat exchanger **104** to have the heat thereof given up to the air in the cold air return **102**. An expansion tank **106** is provided in communication with the pipes **105** in order to allow expansion of the water when heated under pressure to prevent rupturing of the jacket, pipes, or heat exchanger, and additionally a pressure relief valve **39** may be provided for further protection. A thermostatic control means, shown schematically at **107** in FIG. **8**, is provided for initiating operation of the furnace **100** when the air temperature in the confined area to be heated is lower than desired and the temperature of the water in the jacket **10, 10'** and the closed loop associated therewith is lower than necessary to bring the air temperature up to the required temperature. Normally, the conventional fan of the furnace **100** is always running when the jacket **10, 10'** has a fire burning therein even though the heating elements of the furnace **100** need not be activated. Means, such as aquastat **108**, may also be provided to operate the blower portion of the furnace automatically upon a temperature rise within the closed loop/-fireplace hydronic heating circuit.

A modification of the system of FIG. **1** is shown in FIG. **9** for use in a system with a forced hot water boiler equipped to also supply domestic hot water, and electric zone control. The hot water boiler **45** is connected up via a pump **54** and a line **111** to the fireplace jacket **10** (or **10'**), as in FIG. **1**, and a flow control valve **110** is provided. Another line **112** is connected to the line **111** and a line **113** (having the flow control **110** therein), with a pump **54'** therein, which pump **54'** constantly operates with a fire in jacket **10** or **10'** and discharged downstream of the flow control valve **110**. A vent **115** is provided in line **111** for conventional air elimination. Excess pressure relief can be provided by P.V. **39** FIG. **1** or by direct fluid communication of jacket **10** or jacket **10'**, with existing pressure relief facilities of the standard boiler. Three loops (typically) are connected between lines **113** and the jacket **10, 10'**, a living area loop **117**, a second story loop **118**, and a basement loop **119**, each loop having radiators or the like (not shown) disposed therein. A living area thermostat **120** controls the boiler **45**, and water is always circulating through the living area loop **117** when heating is being provided by boiler **45** and/or jacket **10, 10'**. Loop **117** will always be designed to have heat radiation capacity in excess of the BTU output of jacket **10** or **10'**. A second story thermostat **121** operatively controls a valve **125** disposed in line **118** to selectively allow or prevent the flow of liquid through the loop **118**, and a basement thermostat **122** controls a valve **126** disposed in loop **119** to selectively allow or prevent the flow of liquid through the loop **119**. No valves or restrictions are provided in the line **111**. The system of FIG. **9** is useful for heating a three story house having a forced hot water boiler equipped to also supply domestic hot water, with an open-hearth wood burning fireplace according to the present invention.

It will thus be seen that an improved water heating means associated with an open wood-burning fireplace and a wood-burning heating means connected to a conventional heating system or hot-water system has been provided.

While the invention has been herein illustrated and described in what is presently conceived to be the most practical and preferred embodiments, it will be obvious to one of ordinary skill in the art that many modifications may be made therefrom within the scope of the invention, which scope is to be limited only by the appended claims.

What is claimed is:

1. A heating system for heating a confined area, said system comprising

a forced air furnace having hot air ducts extending therefrom and a cold air return extending thereto,

a fireplace jacket comprising means for circulating water directly around an open-hearth wood burning fireplace adapted to have an open fire therein, said fireplace jacket including wood supporting water conducting pipe portions and means for sup-

porting said wood supporting water conducting pipe portions so that they make a positive angle of greater than 0° with respect to the horizontal,

a powered pump,

a liquid to air heat exchanger mounted within said furnace cold air return for transferring the heat of water circulating therethrough to air in said cold air return;

means for operatively connecting said pump, fireplace jacket, and heat exchanger so that water is circulated through said fireplace jacket and heat exchanger in a generally closed loop by said pump, and

an expansion tank operatively associated with said means for operatively connecting said pump, fireplace jacket, and heat exchanger together.

2. A heating system as recited in claim 1 wherein said fireplace jacket comprises a grate member having a first header and a second header vertically above said first header, a liquid inlet to said first header, and a liquid outlet from said second header, said water conducting pipe portions extending from said first header toward said second header and being connected to generally vertically extending pipe portions forming a back of said fireplace jacket, and slanted portions connected to said vertically extending portions and extending vertically back and toward said first header, said slanted portions connected to said second header.

3. A heating system as recited in claim 2 wherein said means for supporting said wood supporting water conducting pipe portions so that they make a positive angle greater than 0° with respect to the horizontal include leg members spaced from said first header and connected to some of said liquid conducting wood supporting pipe portions.

4. A heating system as recited in claim 1 wherein said fireplace jacket comprises means defining a bottom water chamber defined by spaced apart metal bottom walls, said water conducting wood supporting pipe portions being in operative communication with said bottom water chamber, and means defining an opening in said bottom chamber for providing combustion air to fire burning in said open-hearth wood burning fireplace.

5. A heating system as recited in claim 4 further comprising means for connecting said opening in said bottom chamber to a source of combustion air exterior of the confined area to be heated by said heating system.

6. A heating system as recited in claim 4 further comprising a damper disposed in operative association with said opening in said bottom chamber, and means for adjustably controlliing the position of said damper to control the amount of combustion air flowing to the fire burning in said open-hearth fireplace through said opening.

7. A heating system as recited in claim 1 wherein said fireplace jacket comprises a grate member having a first header and a second header vertically above said first header, a liquid inlet to said first header, and a liquid outlet from said second header, and a plurality of liquid-conducting pipes for supporting logs thereon, said pipes extending between said first header and said second header and having portions thereof for supporting wood to be burned in said open-hearth wood-burning fireplace thereon, and means for supporting said liquid-conducting pipe so that all portions thereof make a positive angle of greater than 0° with respect to the horizontal, each of said headers including a prism having a triangular base said prism including a bent plate member forming two legs of the triangle and attached to a straight plate member having a plurality of holes formed therein along the length thereof for connection of the header to said liquid-conducting pipes and said inlet or outlet respectively.

8. A heating system as recited in claim 7 wherein said bent plate member is attached to said straight plate member by welds, and wherein said liquid conducting pipes pass through the openings in said straight plate member and are welded to the straight plate member around the openings.

9. A heating system as recited in claim 1 further comprising a header connected to said fireplace jacket wood supporting water conducting pipe portions, said header including a prism having a triangular base, said prism including a bent plate member forming two legs of the triangle and attached to a straight plate member having a plurality of holes formed therein along the length thereof for connection of the header to said liquid-conducting pipes and an inlet for said liquid-conducting pipes.

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STAINLESS STEEL COMPARISON

The Classic: Stainless Steel Comparison

"Titanium Enhanced" Stainless Steel

Central Boiler SCL models are manufactured using "Titanium Enhanced" Stainless Steel.

"Titanium Enhanced" Stainless Steel is the *stainless* alloy of choice based on its ability to withstand the stress, corrosive environment, and high temperatures that are exerted on your firebox during operation. Carbon steel (used in Central Boiler CL models) also has all the characteristics that you are looking for when deciding on a durable firebox material.

Other stainless steel alloys simply fall short of what it takes to withstand the stresses and corrosive environment that outdoor wood furnace metals are exposed to while they are in use.

" Leaders in product quality, design, and innovation."

Stress Corrosion Cracking

Stress Corrosion Cracking (SCC) is defined as: the failure induced by the combined influences of *tensile stress* and a *corrosive environment.* Combinations of the following conditions can cause SCC: (1) presence of *halide* ions (generally chloride), (2) residual tensile stresses, and (3) temperatures in excess of about 120°F (49°C).

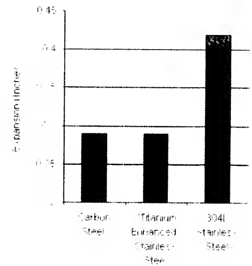
Below are two graphs that illustrate how three outdoor wood furnace metals (Carbon Steel, "Titanium Enhanced" Stainless Steel, and 304L Stainless Steel) react to the high temperatures exerted on them during operation

Thermal Expansion

Thermal expansion is the expansion in metal resulting from an

increase in temperature. The greater the expansion rate, the greater the chance of SCC (Stress Corrosion Cracking) to occur in the metal.

304L Stainless Steel has nearly double the expansion that "Titanium Enhanced" Stainless Steel and Carbon Steel have

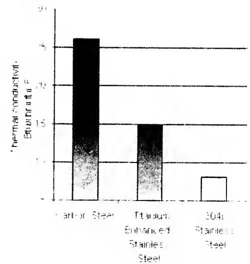


This graph reflects the expansion amount on a 4'x 4' sheet of metal
References: Mechanics of Materials, Beer and Johnston
Material Property Data, MatWeb

Thermal Conductivity

Heat is normally conducted by atoms literally bumping into each other. Metal electrons add to this flow of heat, which is why metals tend to be good conductors of heat. The measure of how good a material is at conducting heat is known as its thermal conductivity. Thermal conductivity is defined as the rate at which heat flows through material.

A firebox material with higher thermal conductivity will boost the efficiency of your outdoor wood furnace by transferring more Btu's into the water jacket, instead of out your chimney.



References: Standard Handbook for Mechanical Engineers, Baumeister & Marks
National Physical Laboratory, Internet

Ferritic Stainless Steel
"Titanium Enhanced" Stainless Steel

Ferritic stainless steels have very useful corrosion resistant properties, such as resistance to chloride SCC, corrosion in oxidizing aqueous media, oxidation at high temperatures, and pitting and crevice corrosion in chloride media.

Resistance to stress-corrosion cracking is the most obvious advantage of the ferritic stainless steels. Ferritic steels, particularly those that are nickel-free, resist chloride and SCC very well.

References Technical Data Blue Sheet, Allegheny Ludlum
Chemical Engineering, Oct 18, 1982

Austenitic Stainless Steel
304L Stainless Steel

Type 302, 304, 304L and 305 alloys are the most susceptible of all the Austenitic Stainless Steels to SCC.

References: Technical Data Blue Sheet, Allegheny Ludlum
Chemical Engineering, Oct 18, 1982

Click here to inspect

This is actual Low Carbon Austenitic Stainless Steel cut out of a wood furnace that failed due to Stress Corrosion Cracking.

Browse our furnace models to find which SCL "Titanium Enhanced" Stainless Steel model will best fit your application.

1-800-248-4681

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A safe, efficient outdoor furnace that can provide 100% of your heating needs. Central Boiler manufactures and distributes the Classic Outdoor Wood Furnace, an Outdoor Wood-fired Hydronic Heater that heats multiple buildings, hot tubs, pools, greenhouses, domestic water and more.

While burning a wood stove indoors can mean many problems, there is an alternative. The Classic

outdoor wood furnace from Central Boiler. Also known as an outdoor wood boiler, this Outdoor Wood-fired Hydronic Heater eliminates the problems associated with indoor burning and allows you to get even more benefits from wood heat. This outdoor furnace can actually improve the indoor environment in your home or business, while eliminating the time-consuming chore of tending a traditional wood stove.